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Office Building of the Consolidated Gas Co., New York City

An office building of 10 acres floor area has been built by the Consolidated Gas Co., in New York City, for its own exclusive use. This unusual condition is matched by unusual factors in the construction of the building. The site is long and narrow, and the middle of its length was occupied by a 12-story building which was only two years old at the time it was decided to cover the whole site with a 19-story building. To avoid the loss of the 12-story building, the new building has been simply built around and over the existing structure. That portion which is immediately over the 12-story building is suspended from heavy plate-girders at the roof level of the new building, spanning across the width of the existing building.

There are some further novelties in the framing of the building, principal among them the very special complications in the framing of the front-wall steel on account of the deep relief of the architecture. Cantilever truss framing is here employed. A complete system of rigid-joint windbracing is provided in the narrow direction of the building.

In erecting the structure, difficulties were encountered in placing the foundations for the columns of the new building alongside those of the old, and it was necessary to tunnel under the footings of the existing building to place the enlarged footing girders required for the new foundation. This was done without disturbing the existing building, without shoring it, and without interfering with its occupancy. In fact, the entire construction work was carried out in such a way as to leave the old building in use, and gradually transfer its occupancy to those parts of the new building which were assigned permanently to the respective offices housed in the existing building.

A predecessor of the Consolidated Gas Co. erected a building on the corner of Irving Place and 15th St., New York City, in 1855. Years afterward, three adjoining buildings on Irving Place and on 15th St. were acquired, and the original plot of 60x90 grew to 84x155 ft. This was the condition three years ago, when the company had finally reached the point of definitely planning its new building, its offices up to this time having been spread through the original building and the transformed residences adjoining. It was decided after exact estimates that the required office space called for a 12-story building on the available plot of ground. The plan was to build first the easterly portion of this building, then transfer the offices into it, tear down the old buildings in which the offices had been housed, and construct the westerly half of the building.

Pursuant to this plan, this easterly portion was begun in the fall of 1910 and was completed by July 1, 1911; it is the part marked "Old Building" in Fig. 2, and the dark-colored portion seen in the view Fig. 1. Just about the time the offices of the company had been moved into the new building and the remaining old buildings had been vacated and were ready for demolition, new conditions arose, and work was stopped pending the preparation of new plans. Several lots lying east of the company's ground were acquired, giving a total length east and west along 15th St. of 297½ ft., thus nearly doubling the ground area of the building site. With this en-

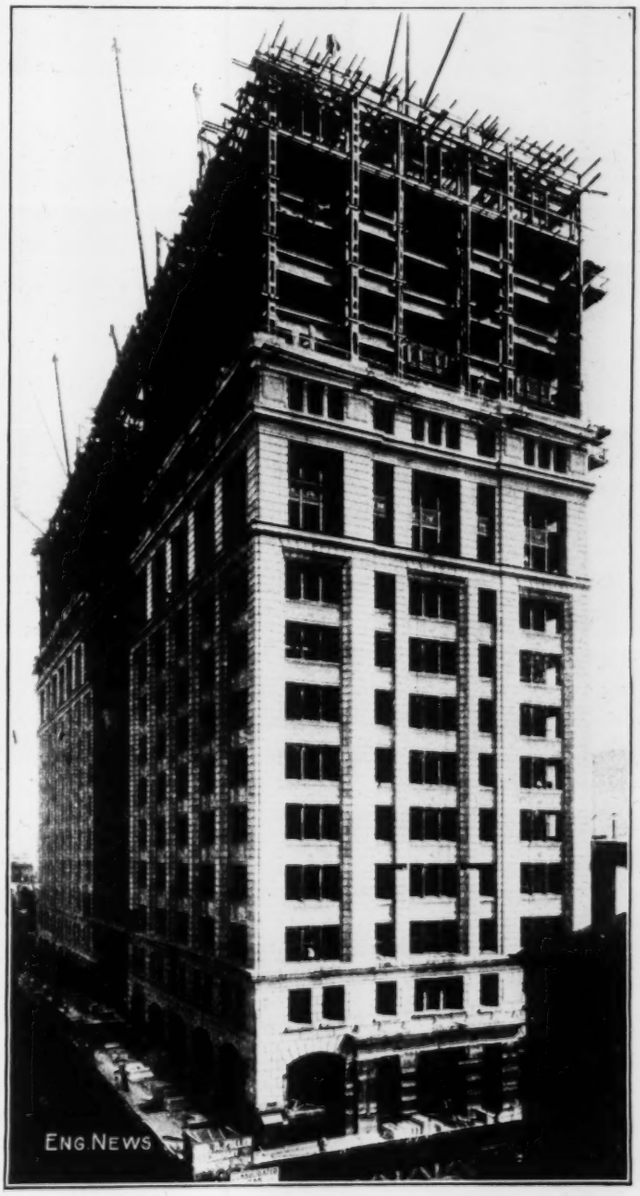


FIG. 1. CONSOLIDATED GAS CO. BUILDING DURING CONSTRUCTION

(Dark portion at middle of 15th St. face is the 12-story portion built first; the cornice framing at the 19th tier level is just being placed.)

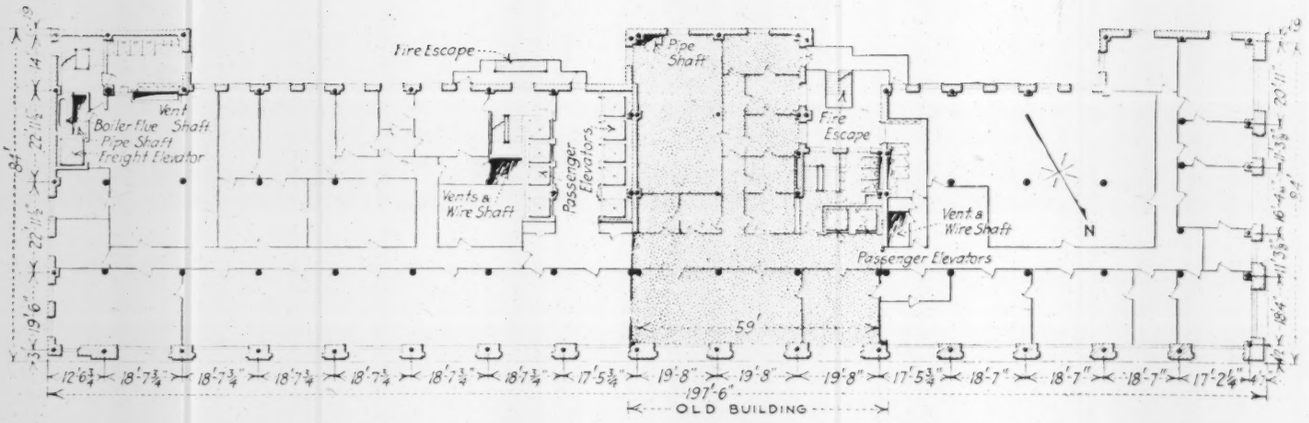


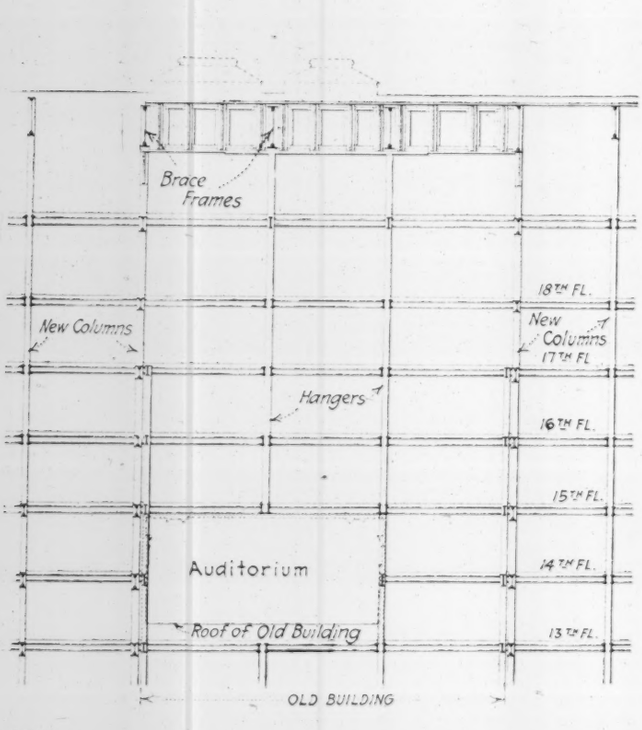
FIG. 2. TYPICAL FLOOR PLAN, CONSOLIDATED GAS CO. BUILDING

larged plot in its possession the company decided that the new building should house not only its own offices but also those of all affiliated and subsidiary companies, the total requiring about three times the space hitherto counted on. Revising the space estimate on this basis gave the result that a new building on the entire enlarged plot of ground would have to be 18 stories high. The height of 18 stories was adopted, and the building has been built accordingly, except that a roofhouse, which is virtually a 19th story, was added for accommodating an employees' restaurant and officials' dining-rooms. There are also three extensive penthouses above the 19th story for inclosing tanks and elevator, ventilating and other machinery.

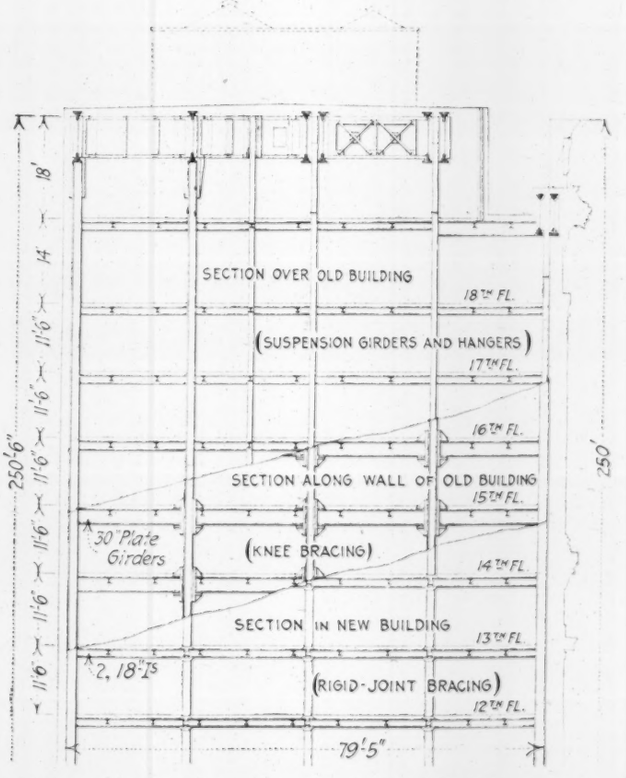
The preparation of plans for the new building was begun in the fall of 1912 and the contractors began work in the spring of the present year. It is expected that the building will be complete in all respects by the early Spring, 1914; the structural parts are complete now and finishing work is in progress.

SIX STORIES SUSPENDED FROM THE ROOF

The 12-story building of 1910—called in the following the Old Building—is about in the middle of the length of the entire structure, as marked in the plan Fig. 2. Its steel framework was not strong enough to carry any additional height, and this required that new supports should be provided for the six-story section just above the old building. To place a new column alongside each of the old columns through the floors and stories of the old building, or to increase the cross-section of the old columns, would either permanently obstruct the floors or require extensive alterations to the existing steelwork. It would have meant in effect vacating the old building, at serious inconvenience to the company, whose offices would have to find temporary quarters for a year. There-



PART EAST-WEST SECTION



NORTH-SOUTH SECTION, SHOWING WINDBRACING

FIGS. 3 AND 4. SECTIONS OF CONSOLIDATED GAS CO. BUILDING

the scheme of spanning the space above the old building by girders or trusses was resorted to. Of the various ways of applying this scheme, the one adopted has the merit of leaving the interior space of the seven added stories quite unobstructed, while other ways would have involved such obstruction. Thus, transverse trusses just over the roof of the old building, to support the columns of the addition, would have cut up one story so badly as to destroy its value; and plate-girder floor-beams across the width of the old building would have required an impossible infringement on the headroom of each added story.

verse section of the new building), it will be seen that the front girders are at a lower level than the others. This is because the 19th story is set back from the front wall by the width of a walkway on the roof just back of the main cornice. The other girders are above the ceiling of the 19th story, and inclosed in the space between this ceiling and the roof, a space resulting from the depth of trusses used to support the roof over the new portions of the building, interior columns being here omitted to obtain clear floorspace in the dining rooms. Consequently the placing of the plate-girders above the 19th story does not increase the height of the

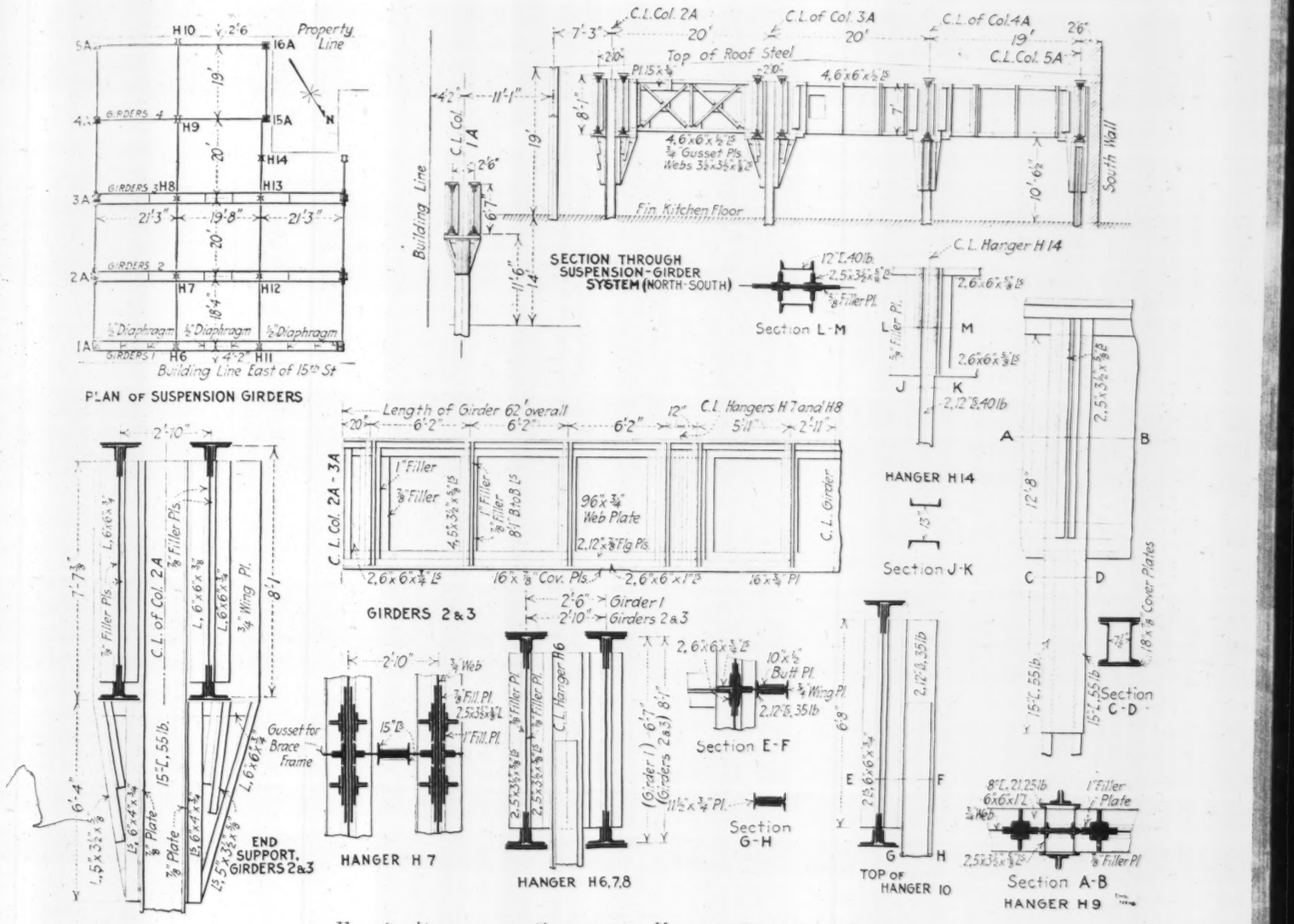


FIG. 5. DETAILS OF GIRDER-AND-HANGER CONSTRUCTION

The east-west section, Fig. 3, which is a part longitudinal section of the new building and at the same time a transverse section of the old building, shows the general arrangement of this girder-and-hanger structure. There are eight girders, as may be seen from the north-south section, Fig. 4. The two rear ones are short, while the six forward ones are considerably longer and in pairs. The pair of girders in the plane of the front wall, which carries the front wall but only half a floor panel, is not as heavily loaded as the two back of it. The second and third pairs are the heaviest.

Referring to the north-south section, Fig. 4 (a transstructure or entail an unsightly projection above the general skyline of the building.

Some details of the girder-and-hanger construction are shown in Fig. 5.

It may be noted that the story immediately above the roof of the old building contains neither columns nor hangers. Advantage was taken of this to construct a large auditorium or lecture hall there, occupying the width and length of the old building. Because the hangers of the upper part of the building are thus left without the stiffening which would be realized if they were continuous with the columns below, they are provided

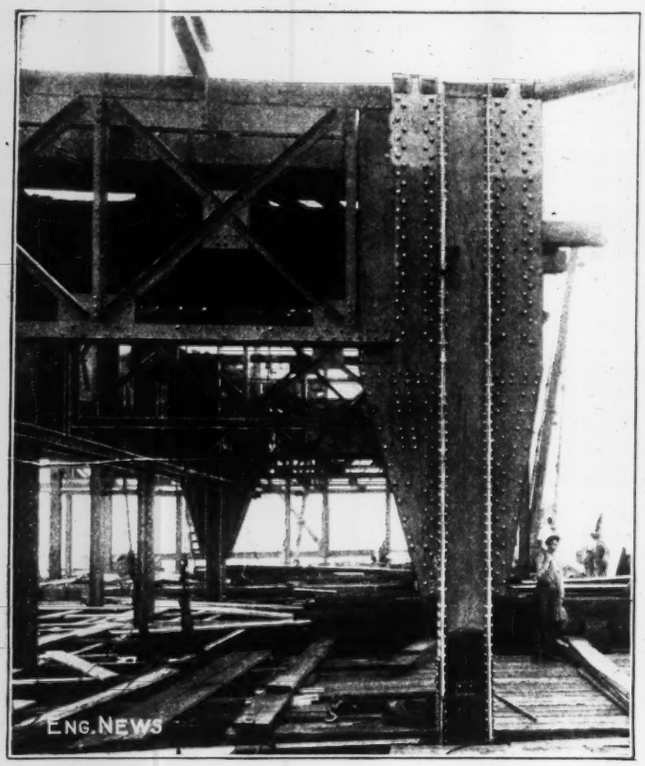


FIG. 6. GUSSET AT COLUMN FOR CARRYING PLATE-GIRDER FROM WHICH SIX STORIES ABOVE OLD BUILDING ARE HUNG

with a set of horizontal crossed diagonals at their b... ends, the 14th floor, i.e., the level of the ceiling of ... lecture hall.

The girders are 8 ft. 4 in. deep, and on account of ... great loads and bending moments involved, the gir... are in pairs, consisting of two I-sections side by s... The details of special interest are the end connections and the hanger connections. The former involve the ... of immense tapering gusset-plates, as drawn in Fig. 6. This connection was designed to avoid eccentricity and is believed to distribute the load over the full column section quite equally because of the great depth of the gusset-plate. The gusset-plate substitutes for and continues the center web-plate of the column; the joint is not spliced, but direct bearing is counted on, the edges being faced.

The hanger section and the connection of hanger to girders is seen to be simple and to assure a direct and central transfer of load. The connections of floors to the hangers are normal and central, except at one or two special points as in the case of the hanger in the reëntrant angle of the large light-court, which for convenience is placed clear of the wall and requires several connections 8 to 12 in. eccentric.

SPECIAL FOOTINGS

The foundations of the building are on rock. The site has rock so near the surface that the point of deepest excavation for footings was not more than 10 ft. below the cellar level.

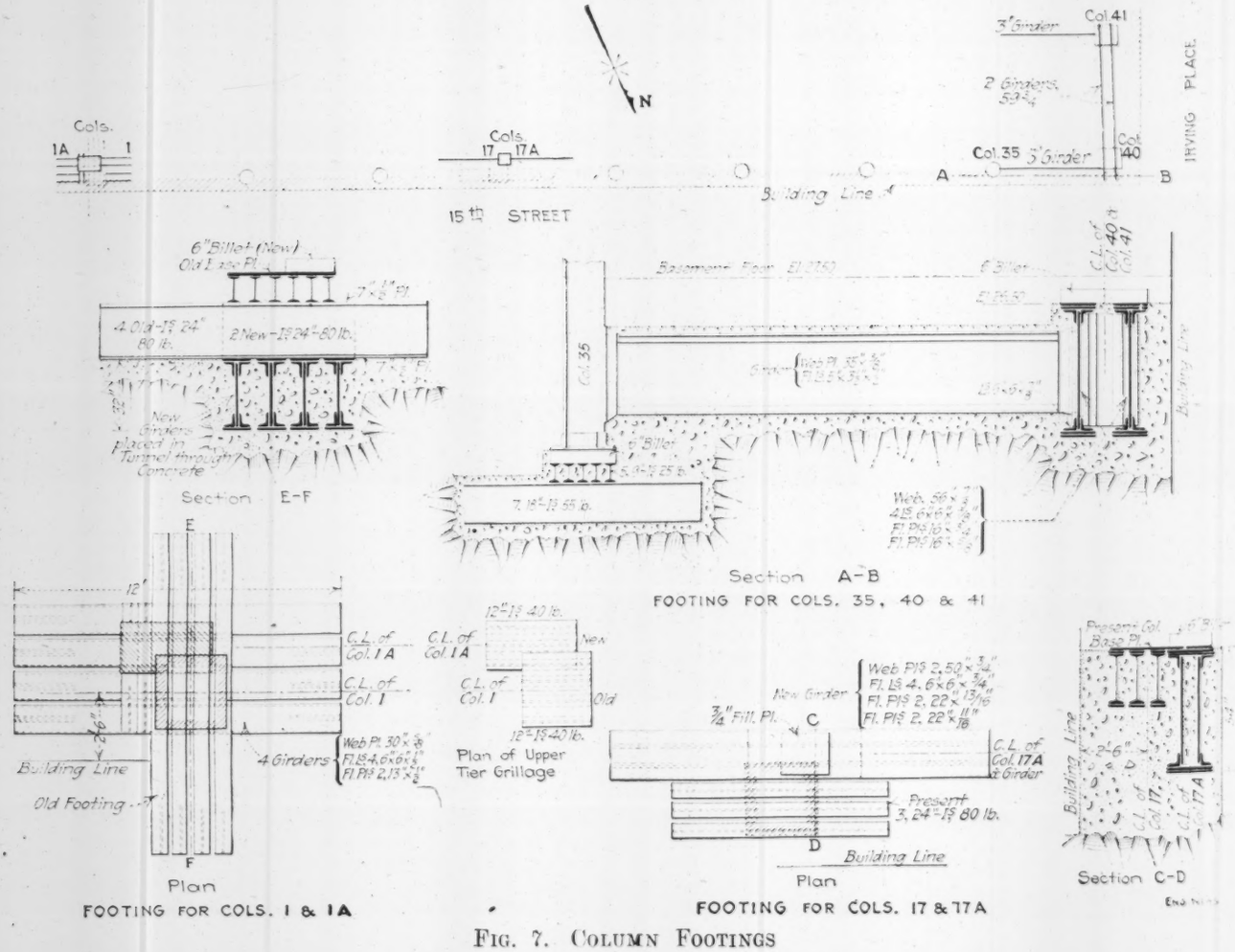


FIG. 7. COLUMN FOOTINGS

As the exterior of the new building was to continue and develop the face architecture of the old building, not only the column spacing but also the pier width were fixed. Considering the 15th St. wall, the new columns adjoining the east and west corners of the old building had to be set very close to the old columns in order to come within the limits of the masonry pier. A similar difficulty, though less imperative, occurred at the other columns in the line of the side walls of the old building. In each case the new column came on a corner of the footing grillage of the old column, and the problem was to develop a suitably enlarged single footing for the two columns, without disturbing the old columns.

The difficulty was solved by tunneling through the concrete of the old footing and placing the girders of the new footing under and at right angles to the old grillage beams, then blocking up to a level with the top of the old footing and placing here a 6-in. steel slab as a distributing plate for the base of the new column. The new footing girders were wedged up against the underside of the old grillage, thus transferring the load of the old column to the new footing where it and the new column are carried together. This work was performed without shoring either the old building or its columns.

The sketch, Fig. 7, shows the footing of the front-wall column. This is typical, the other columns presenting the same general problem, with differences in detail. An exception is the footing of the rear column at the southeast corner of the old building, where, on account of property limitations, the old column had a reinforced-concrete spread footing confined wholly within the property line. One-half of this old footing was cut away from under the column and replaced by a box girder wide enough to accommodate half of the base of the old column and the entire base of the new column.

It may be said, with reference to the front-wall column footing, Fig. 7, that in 1910, when the old building was designed, the city permitted foundations to be built beyond the street line; but by the time of designing the enlarged building it had become practice to refuse authori-

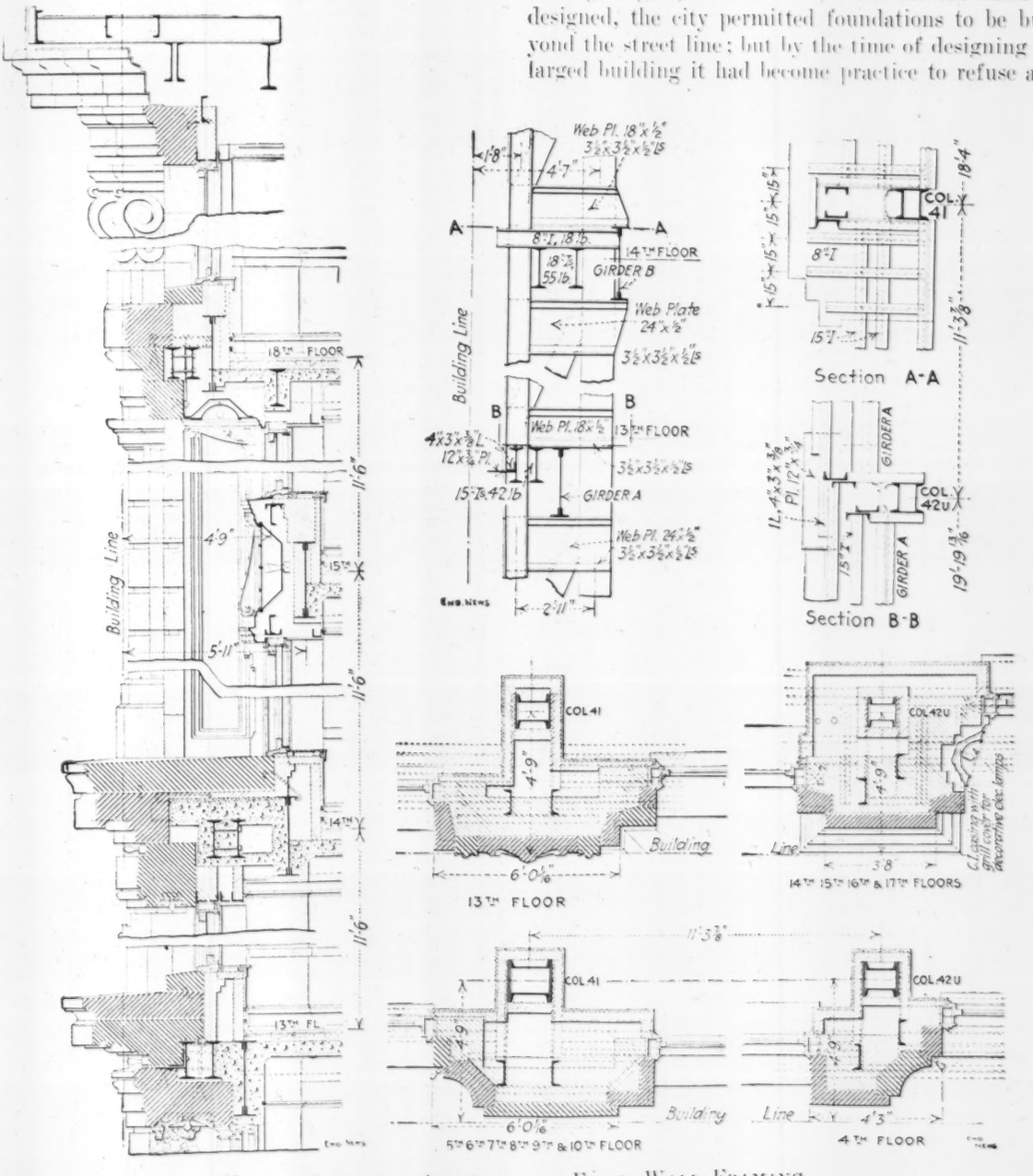


FIG. 9. SPANDREL SECTIONS AND FRONT-WALL FRAMING

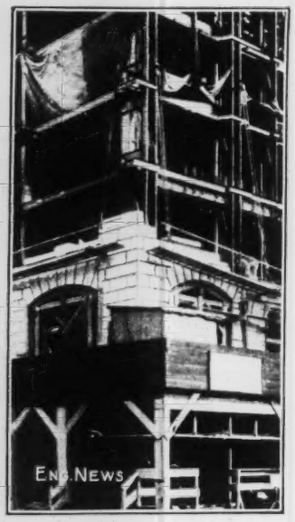


FIG. 8. FRONT FRAMING

(Cantilever framing in Irving Place wall to carry irregular architecture.)

zation for such extensions. Therefore, the new footing could not be built with grillage beams parallel to the old ones, but the beams had to be run east-west, parallel to the street line.

The new columns along the walls of the old building are so close to the old ones that vertical channels had to be cut in the brickwork before they could be set in place. This was done with pneumatic chisels. Similarly, channels had to be cut for the plate-girder floorbeams; in a few cases the wall was cut through nearly its full thickness. The existing wall-beams were taken out before placing the girders, by cutting through near each end with a torch.

FRONT-WALL FRAMING

The long 15th St. front, detailed to match the architecture of the front of the original 12-story building, is simpler than the Irving Place front and required fewer special features for the steel design. The Irving Place front, however, is not only provided with a high portal and entrance lobby, but has wide projecting belt-courses and recessed stories in irregular alternation, with the general result that the front row of main columns had to be set about 5 ft. back of the property line, to clear the recessed work, and special arrangements had to be devised for carrying the stonework (and some floor load) in front of this line. The special framing for this purpose consists of what is really a cantilever truss, composed of a line of wall-columns 3 ft. 6 in. in front of the main columns, and downwardly inclined hangers

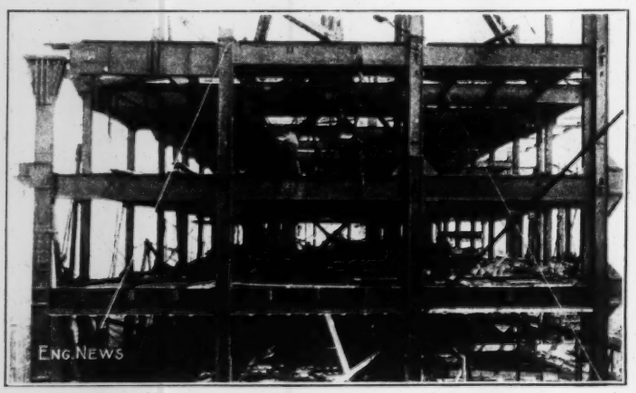


FIG. 10. GIRDER AND KNEEBRACKET WINDBRACING IN PLANE ALONG EAST FACE OF OLD BUILDING

(Such bracing used in four north-south planes.)

from the main columns supporting these wall-columns, in connection with struts at the floor levels to complete the truss. Fig. 8 shows the appearance of this framing during erection, and Fig. 9 gives a typical section. The spandrel beams, and special supporting beams for belt courses where necessary, are attached to the wall-columns or to the struts at floor level in various arrangements as required by the overhang of the stonework. The section in Fig. 9 includes the main belt-course level, the floor.

Special column arrangement was required at the large portal occupying the center of the Irving Place front. Two stone pillars two stories high are set in this portal, but it was not considered safe to depend upon them to carry any of the steelwork above. The entrance lobby extends back of the front row of main columns, so that the two main columns which came over the lobby had to be supported at the level of the roof of the lobby. The stone pillars are made hollow and contain each a steel column, which in erection was set up first and the successive disks of stone threaded on it. Steel columns are also set in the line of the rear wall of the lobby, extending to the roof of the lobby. Two triple-web longitudinal girders span across these columns, from the columns in the stone pillars to the next inner row of main columns, and carry the main columns of the upper central portion of the front of the building.

GENERAL FRAMING

The general framing involves the rigid-joint type of beam-and-column connection as windbracing in the north-south direction, see Fig. 11. All the floorbeams running north-south between columns are double and pass outside the column, being riveted to them with a

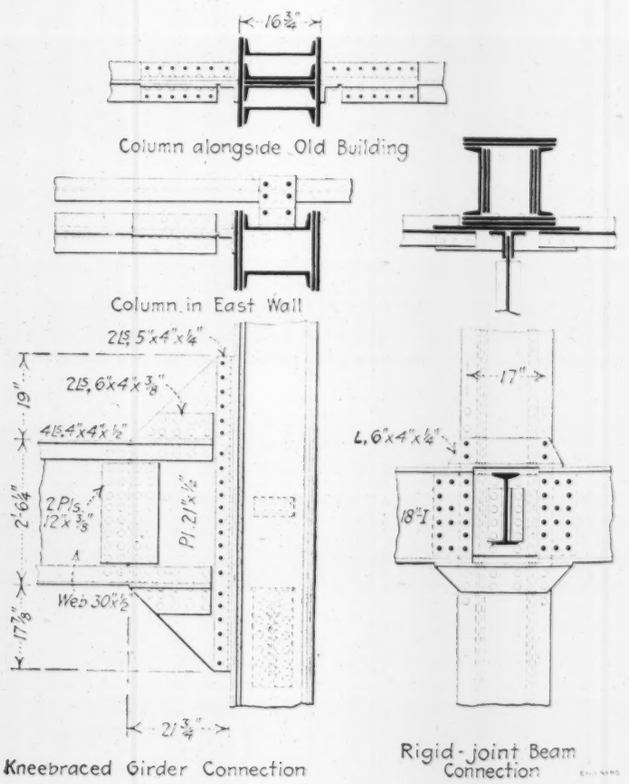


FIG. 11. RIGID JOINTS OF WINDBRACING SYSTEM

group of rivets having sufficient moment capacity to resist the distorting moments due to wind pressure. The subsidiary joists run east and west and are framed into the double beams.

The general panel dimensions are 20 ft. north-south by 18 ft. east-west. The floor joists are spaced about 6 ft. on the average, carrying a cinder-concrete floor-slab of that span. There are no cross-walls in the building

its entire length of 297 ft., except the remains of east and west walls of the old building, as indicated the typical floor plan, Fig. 2. The stiffening effect is, erefore, due entirely to the windbracing. This inades, besides the floorbeam connections, four lines of

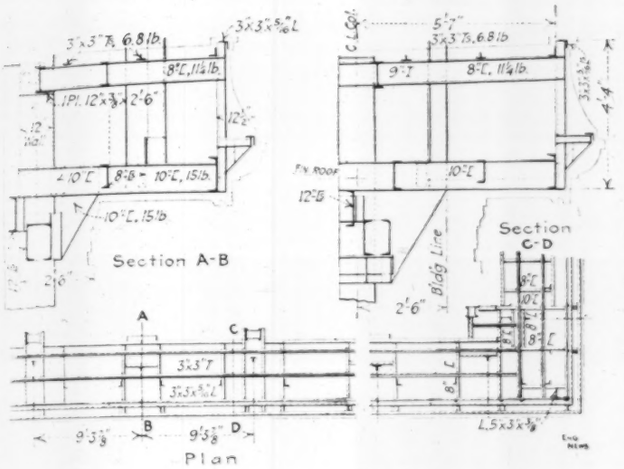


FIG. 12. CORNICE FRAMING

special wind girders in the front or west wall, the east wall, and along the sides of the old building. Here 30-in. plate-girders are used in place of the regular double floorbeams, with enlarged gusset-plates forming knee or bracket connections (Fig. 11).

Horizontal diagonal bracing is introduced at several points of the structure to give rigidity against special forces or conditions.

CORNICE FRAMING—A special feature of the framing is found in the structure of the main cornice. The cornice comprises a molded copper projection about 5 ft. wide, and on it a series of copper ornaments 8 ft. high. It is supported by steel channel-and-angle framing carried at each column by a rectangular trussed bracket (Fig. 12), the columns projecting about 3 ft. above the beams of the 19th tier to provide support for the brackets. The resulting bending moment in the columns (especially with regard to wind pressure against the copper ornaments) is absorbed by the 19th tier floorbeams framed to the columns; plate-girders 30 in. deep are used for these floorbeams (in the north bay) in place of the double channels used elsewhere.

DINING-ROOM TRUSSES—The roofhouse in its easterly half contains the employees' dining room, and this is roofed with large arch-shaped trusses. The trusses are protected with concrete, the members being incased individually to avoid the weight of a solid block. In the line of the lower chord of the trusses there is a steel-furred suspended ceiling. Above the trusses is the cinder-concrete slab of the roofhouse roof, carried by steel purlins. The roof covering is tarred felt and gravel.

Separate penthouses for the elevator machines and at the east end for a rectangular 30,000-gal. water-supply tank and other machinery project above the line of the 19th story.

DESIGN OF STEEL—The framework and floor slabs were proportioned for a live-load of 120 lb. per sq.ft. on all floors. This corresponds to the loading required for loft buildings, rather than office buildings. The windbracing was proportioned more by judgment than as the result of definite calculation on the basis of any artificial assumption, although such calculations were made, on various sets of assumptions, with the result of showing the structure to be amply rigid, with excess.

OTHER STRUCTURAL PARTS—The walls of the building are of brick. The face walls (Irving Place and 15th St.) are faced with limestone, to their full height. The other two exterior walls are plain brick walls, with paneling of darker-colored brick to relieve their bareness, following a custom now becoming general in New York City.

The floors are 5-in. reinforced (triangle-mesh) cinder-concrete slabs 5 to 6 ft. in span, with 2 in. of lean cinder-concrete fill above, in which the pipes and wires are em-

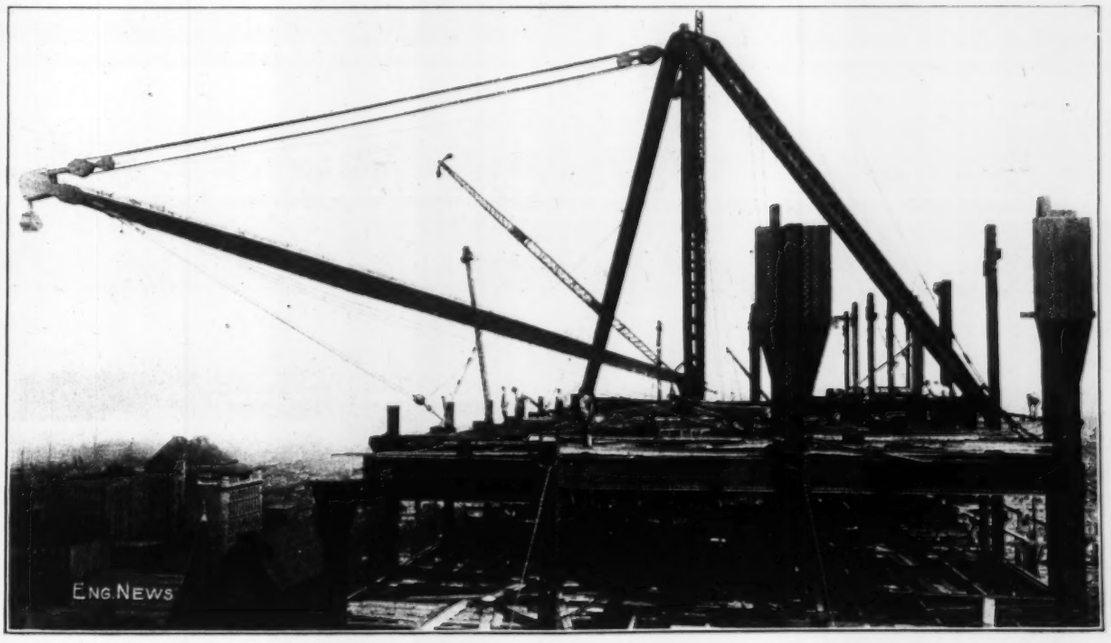


FIG. 13. 80-TON STEEL DERRICK ON 19TH TIER FOR HOISTING LARGE PLATE-GIRDERS; CONSOLIDATED GAS CO. BUILDING

(Boom 70 ft. long. Timber strutting under derrick base distributes the maximum reaction of 140 tons.)

bedded, topped off with a 1-in. cement-mortar surfacing. The floor surfaces in many of the rooms will probably be left bare; in the corridors terrazzo (concrete mosaic) will be used; in the best offices cork tiling is to be laid.

The interior partitions consist generally of 4-in. terra cotta, held by the pressed-steel framing of the doors and other openings. All exterior doors, sash and frames will be of hollow steel, those in the rear wall hollow copper, and those in the front bronze-covered wood. The interior steel "woodwork" will be painted and grained to imitate wood.

The stairs, of which there are two, one at the east end and one near the center of the building, are built with marble platforms and treads on steel stringers and risers.

Steam and Water-Supply—The old building was served by a roof tank and a boiler room in the basement. The boiler room of the new building is at the east end of the basement, and the water tank is above the roof at practically the same location. The old building remaining in service during the entire construction, it was necessary to transfer the steam and water service from the old to the new equipment without interruption. As the old boiler room is to be occupied by the switchboard of the completed building, it was not possible to keep the old boilers in service until final completion. As soon as the new boilers were ready for service, cross-lines were run from them through the basement to the steam mains of the old boiler room, whereupon the old boilers could be cut off and service maintained until the permanent connections to the risers are mac. The water service was taken care of after the completion of the new tank by running a main along the 12th floor to the top of the old riser system and then cutting out the old tank.

Ventilation of Building

There are two main vent shafts through the building near the two central groups of elevators. In addition each set of toilet rooms has its own vent shaft and there are one or two special vent shafts.

The two main vent shafts have at each floor a transverse overhead inlet duct which opens on the main longitudinal corridor with a grill. The corridor has two swing doors cutting off the main or end portions from the central section, and the vent ducts are in the end sections, just beyond the doors. The end portions of the corridor do duty as branches of the vent ducts.

A separate vent shaft serves the first story (on account of its lack of window ventilation to light courts, these being roofed over at the second-floor level) and the basement. This duct is in the rear wall of the old building.

Each vent shaft has its own motor-driven exhaust fan in a house over the top of the shaft.

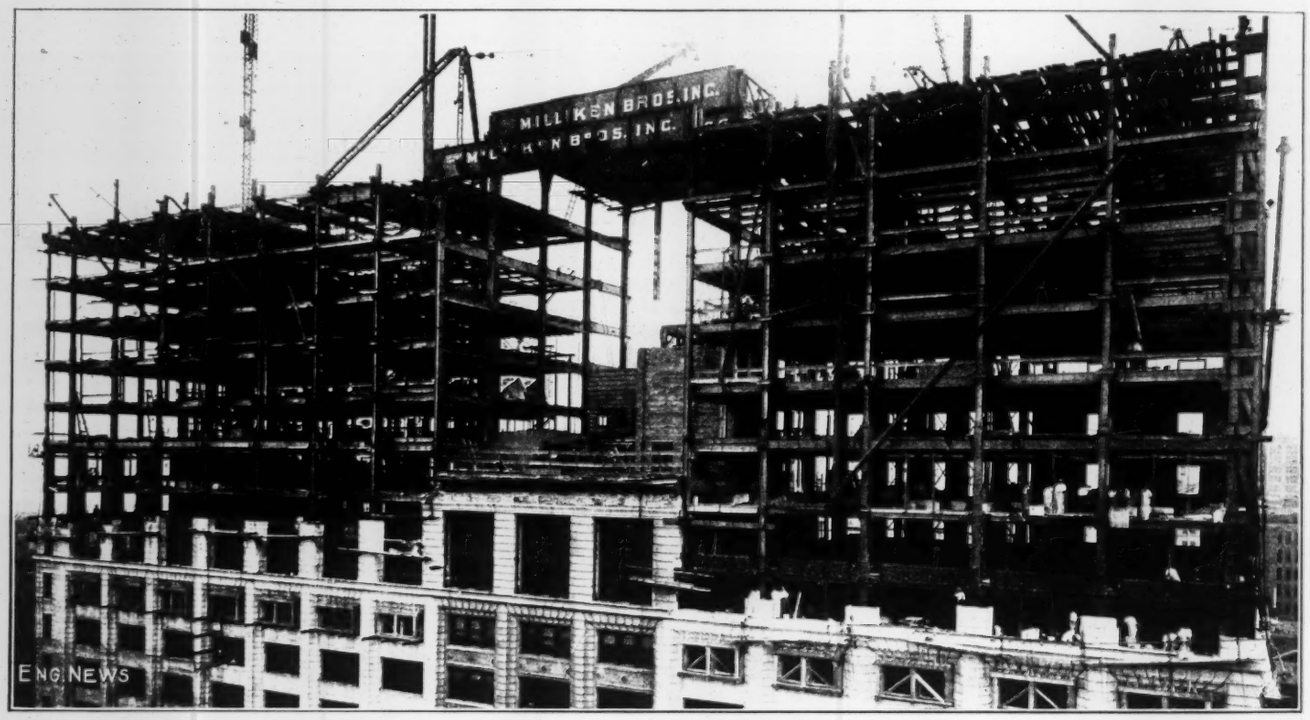


Fig. 14. Erecting the Girder-and-Hanger Construction for Carrying Six Stories over the Old Building

Fire Escapes

Two outside steel platform-and-stair fire escapes are provided. One of these is a separate stack or open tower, with the stairs about 8 ft. distant from the building walls. It occupies the court at the southwest corner of the old building. Bridge platforms are connected to a window on either side of the court at each floor. The other fire escape is directly against the rear wall of the building, the inner edge of the stair being 3 ft. away from the building, the width of the passageway along the platform.

In these fire escapes the platforms are made of 1-in. by ¼-in. bars on edge, supported by channel stringers between single-angle posts suitably braced. The stairs have steel channel stringers and steel checkered-plate treads.

OUTSIDE LIGHTING—Special decorative lighting has been planned for the exterior of the building. This includes cast-iron frames or edgings and spandrel panels set in all the window embrasures above the fourteenth floor, containing electric incandescent lamps in recesses of the frame; cornice lamps and groups of lamps in the elements of the copper projection above the cornice; straight lines of border lamps in the window panels below the fourteenth story; and two gas torches on the roof.

There are various other interesting items in the equipment of the building. For example, the arrangement of gas, electric and signaling distribution for extra purposes is worth notice. In each room there is brass floorplate with outlets for four services: gas, electric-lighting current, telephone wires, and bell or signal wires. The outlets are contained in a four-compartment iron box covered by the floorplate; screw plugs in the plate give access to the outlets. The telephone wires and the lighting wires in the floorplates are for special use only. The general telephone wiring is carried in the picture molding, and the electric-lighting wires to the permanent ceiling fixtures are in steel conduit embedded in the concrete fill of the floors.

The architectural design of the Irving Place and 15th St. fronts was the work of H. J. Hardenbergh, and with this exception the building was designed and built under somewhat unusual circumstances in that all other engineering, designing and supervision were performed by the Engineering Department of the Consolidated Gas Co., William H. Bradley, Chief Engineer, W. Cullen Morris, Engineer of Construction. All designing drawings and all specifications for masonry, marble work for entrances and ground-floor offices, interior partitions and trim, plumbing, lighting, heating and ventilating, were in charge of J. F. Hunter, W. L. MacIntosh and A. W. Stark.

The designs for the foundations and structural steel, including the large girders and other special structural features which have been described, were made by Herbert W. Alrich, of the engineering staff of the company.

The general contractors for the entire building were the George A. Fuller Co., C. L. Pierson, Superintendent. Milliken Brothers, Inc., were the contractors for the steelwork, which was erected by them under the superintendence of H. A. Colvin.

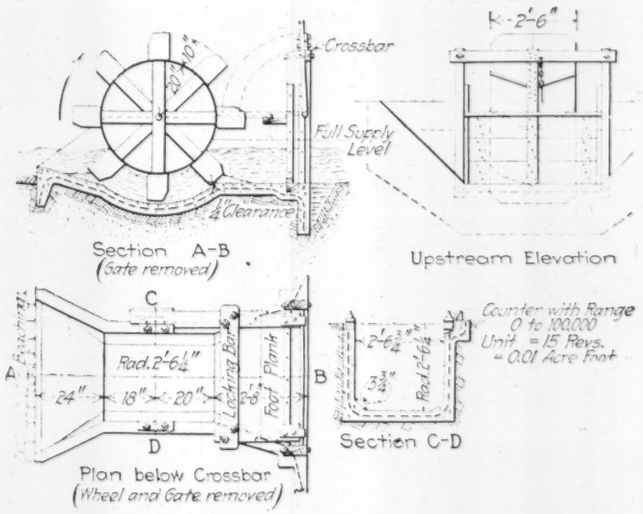


FIG. 1. AN AUSTRALIAN WATER METER FOR IRRIGATION DITCHES

An Australian Water Meter for Irrigation Supplies

The government of Victoria, Australia, requires that water be sold to irrigators by measure. To meet this requirement, the State Rivers and Water Supply Commissions for a while were in difficulty, not being able to find a suitable meter or to prescribe satisfactory conditions for reliable orifice measures, since the pressure head is too small over much of the area.* Finally one of the members of the Commission, J. S. Dethridge, of Melbourne, devised a simple meter, which has proved effective in three years' use, there being now some 2000 in use in Victoria and New South Wales. It should give satisfaction in much of the irrigable territory of the United States as it can be built here probably considerably cheaper even than in Victoria.† The accompanying description and drawings have been secured through the courtesy of Elwood Mead (Chairman of the State Rivers and Water Supply Commission and Chief Engineer of the Water Supply Department of Melbourne, recently appointed head of the new Division of Rural Institutions at the University of California).

The standard size of the Dethridge meter, shown in the accompanying figure, has a delivery capacity from ½ to 4½ sec.-ft., the head required varying from ½ to 3 in. respectively. For this range the variation in accuracy does not exceed 3%.

The meter consists of an open cylinder, to the external surface of which angular vanes are riveted. Both cylinder and vanes are of 20-gage sheet iron coated with anti-corrosive preparation. This rotor is keyed to an axle of 1-in. pipe and revolves in an outlet box of reinforced concrete with ¼-in. clearance between vanes and case. The bearings are blocks of hard wood. Registration is kept in acre-feet by a cyclometer connected with the axle and protected from spray. It is found that ordinary floating débris causes no trouble, the rotor having power enough to crush it. The cost of a meter complete, set in place, ranges from $10 to $60, according to location.

The merits of the meter are delivery with small loss of head, accurate and continuous record, and freedom from risk of being tampered with, because effective supply is stopped by any interference with the rotor. A gate

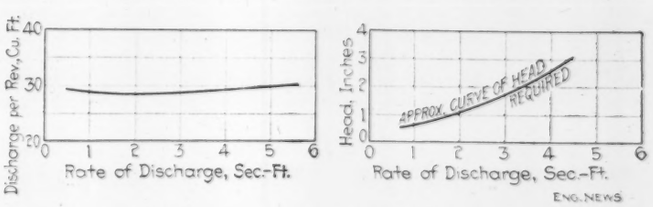


FIG. 2. DISCHARGE CURVES FOR DETHRIDGE METER

is provided for shutting off or regulating the flow, the latter being an easy matter as the guard has simply to allow one revolution per minute for each ½ sec.-ft. There is also provision for locking the rotor when not in use but it is found in practice that the water left in the hollow of the case is a sufficient anchor against revolution by wind action.

*The Grant-Mitchel meter, an Australian device, having a horizontal wheel with radial vanes and set in a circular orifice, was described in "Engineering News," Mar. 26, 1908.

†Weir devices in use in the United States were described in "Engineering News," Aug. 29, 1912, together with the Hill meter—a development of the Grant-Mitchel device.

The New Big Bear Valley Dam; a Concrete Dam of the Multiple-Arch Type

By John S. Eastwood*

The Big Bear Valley is a glacial valley lying on the summit of the San Bernardino Mountains, about 30 mi. in a direct line easterly from Redlands, Calif., at a general elevation of 6750 ft. above the sea level. The site was early considered as a possible storage site and was finally developed in 1884 by F. E. Brown, of Los Angeles, Calif., to furnish a water-supply for the city of Redlands and vicinity and was the means of creating that now famous

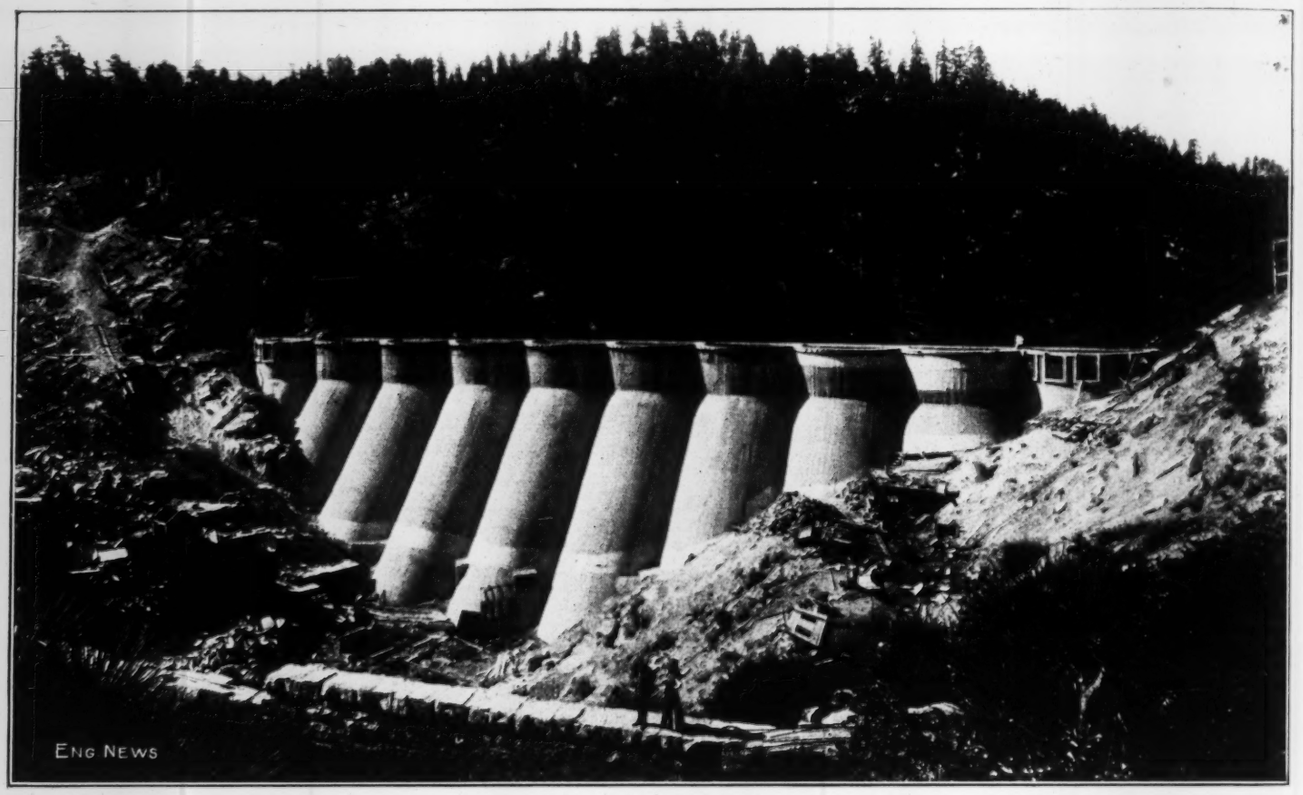


Fig. 1. Front View of New Big Bear Valley Dam Just before Filling of Reservoir
(Old masonry arch dam in immediate foreground.)

citrus area, one of the most highly cultivated sections in the United States.

The Old Single-Arch Dam

Mr. Brown's development consisted in the erection of the famous example of single-arch dam, noted as the lightest section masonry single-arch dam in the world. This old dam has been described many times and many a critic of note has visited it. It has been condemned by many as absolutely unsafe and the adverse criticism was so profuse and from those considered in such high authority that the reservoir was not allowed until the last few years to fill up to its complete capacity, but the winters of 1909-10 and 1910-11 produced a runoff from the drainage area so large that the dam was overtopped during both winters to a depth of over 2 ft. and the earth that had been piled against the lower side of it carried away.

The amusing feature of the attempts to strengthen the old dam was the piling of loose earth and rock against the downstream side of the dam, which the water topping the dam immediately carried away. It is apparent to anyone who has given the subject of the stresses in a water-loaded arch any thought whatever, that this material took no load and added no strength whatever to the dam.

The old dam was built* by Frank E. Brown, in 188[illegible]. It is a single-arch dam of rough-cut granite blocks laid up in cement mortar, in top plan a curve of 300 ft. radius and about 450 ft. length. It is 3 ft. 2 in. thick at its crest, 64 ft. above the footings, increasing in thickness to 8 ft. 5 in. at a point 16 ft. above the base, below which a square offset increases to 20 ft. thickness through the remaining 16 ft. It stored a height of 60 ft. of water. Owing to the difficulties of transportation and the pioneer conditions, the construction of the old dam was a very difficult job, its light section being determined on to reduce its cost to the minimum. A peculiar feature of its construction was that it was built up from a float on the water side, the water being allowed to rise with the dam. This method has been given the credit by some engineers for the paradoxical (?) strength of the dam. Frankly, it was a good test to submit the green structure to the full water pressures. The argument of its adding strength was that it compacted the joints of the masonry, bringing the blocks of stone into a more intimate contact during the time of setting, the mortar being a lime-tempered cement mortar in which coarse sand was used.

The old dam was and is a better structure than it has ever been given credit for and, while it was built for economy only, it met more nearly the requirements that

*Consulting Engineer, Hearst Bldg., San Francisco, Calif.

*See description and views of old dam, "Engineering News," Apr. 7, 1888, p. 271; June 23, 1888, p. 513.

later investigations have shown to be fundamental than many of the more widely heralded structures that were built regardless of cost. Frank E. Brown, the pioneer, built better than he knew and his work has stood the tests of flood to confound his critics whose strictures on his work now sound like those made as to the futility of Fulton's first steamboat.

Studies for New Dam

While the old dam was perfectly safe structurally, it was not high enough to store the amount of water required by the growing demands of the neighboring citrus groves, so some years ago studies were started toward the construction of a new dam or the raising of the level of the old. Several schemes were presented for utilizing the old dam, but all were finally abandoned, owing to the necessity of emptying the reservoir, the water in which was needed as a possible irrigation supply. Consequently, a new dam was decided upon, and studies were presented by the late James D. Schuyler for a gravity-section concrete dam and by the writer for a multiple-arch hollow-concrete dam, similar in design to that built by the writer for the Hume Lake Dam. The multiple-arch design was accepted and built.

It was proposed to erect a dam to a height of 65 ft. above the base datum zero of the old dam, giving a capacity in millions of gallons of 17,000, but the large run-off of the winter of 1909 showed that there would have been lost a considerable quantity of water at that height, so it was finally determined to run it up to the 70-ft. contour, giving it a capacity of 21,000 millions of gallons and this in the completed plans was raised finally to the 72-ft. contour, giving a capacity of 22,880 millions of gallons, the new datum giving a crest elevation of 6746 ft. above sea level.

Design of Dam

The multiple-arch dam is composed of a number of concrete buttresses, supporting a water-resisting deck of concrete arches sprung between the buttresses. The new Big Bear Valley Dam consists of ten arches of 32 ft. clear span, abutting on eleven buttresses. The total length of the dam is 363 ft. on the crest; its maximum height from crest to base is 92 ft. (in a pocket at the middle buttress only), although, as the elevation in Fig. 3 shows, the average height of the buttresses is much less than that figure.

The water face of the structure and the rear edge of the buttresses are given such slopes as to bring the resultant of the water-pressure load and that of the structure through the center of the base of the buttresses at the highest portions. (Fig. 4.) The slope for the water face up to within 14 ft. of the top or 1¼ on 1 or 36° 52′ from the vertical and from that point to the crest, is vertical. The slope of the downstream edges of the buttresses is 2 on 1 from the bottom to the top, the vertical top of the arches giving them a top width of 10 ft., from the spring line to the back edge.

The buttresses are 1.5 ft. thick at the top and increase in thickness with a batter of 0.016 ft. per foot of height or 1 in 60 on each side to the base for all heights. The arch rings are 12 in. thick at the top and down to the bend, from which point they are increased in thickness at the rate of 0.014 ft. per foot measured on the slope, to the base, or 1 in 72.5.

The arc of the extrados of the arch ring is 140° 08′ from top to bottom, the radius being maintained at 17 ft. and the rise at 11.22 ft. The extrados is, therefore, a cylindrical surface uniform throughout, all changes in dimensions being made on the intrados of the arch. Thus at the top the radius of the intrados is 16 ft., the arc 145° 08′, the rise 11.74 ft. At 80 ft. from the top (Fig. 1), the thickness of the arch ring will be 2.15 ft., the radius of the intrados 14.85 ft. (the radius of extrados less the thickness of the wall), the arc 140° 48′ and the rise 10.59 ft. In all cases the clear span, radius and rise of the intrados decrease from the top downward.

Strut-tie members are provided between the buttresses to stiffen and take the lateral thrusts that might be set up by seismic disturbances or vibrations of any kind. These strut-ties consist of a combination of T-beam and a supporting arch all tied together by heavy steel reinforcement.

The T-beams are 12 in. thick and 2.5 ft. wide with a 12-in. stem, set on an arch 12 in. square at the crown and

Fig. 2. Old Dam at Right and New Dam at Left

thickening 15 in. toward the springing lines with two spandrel posts on each side connecting the beam and arch, all united into one piece. There are provided copings for the arches and the tops of the buttresses with 9-in. projections, making the arch cope 2.5 ft. wide and that on top of the buttresses 3 ft. wide. The beam of the top strut members is built 4 ft. wide to serve as an extra stiffener, as well as a comfortable footwalk across the dam. The footwalk is provided with a cable railing on both sides to make it a safe place upon which to walk. To add to the architectural effect of the structure, the arches of the strut members terminate in imposts, built as part of the buttresses.

The struts are reinforced with twisted steel rods, all being tied together and all being continuous through the buttress walls. The ends entering the buttresses are attached to other reinforcements passing crosswise into the buttress walls forming roots by which the stresses in the beams may be transmitted and distributed in the buttress walls. The ends of the strut members are all tied into the granite rock at both ends of the structure by hooking the reinforcement rods in drill holes in the rock. The buttresses are not reinforced, except to be tied to the arch rings and the strut members, their shape and the loads they are to carry making reinforcement superfluous.

The arch ribs are reinforced with ¾-in. twisted rods horizontally disposed 2 in. from the inner surface and variably spaced. These rods were tied to the rods protruding from the buttresses. Ribs of 1½x1½x⅜-in. angles were used for reinforcing the extrados of the arch

shaped basin of concrete and be discharged below the dam, flowing down the slope on the bedrock (Fig. 5).

The spillway has over twice the capacity of that in the old dam for a storage capacity of over three times, though it may never be used at all, unless an unusually wet win-

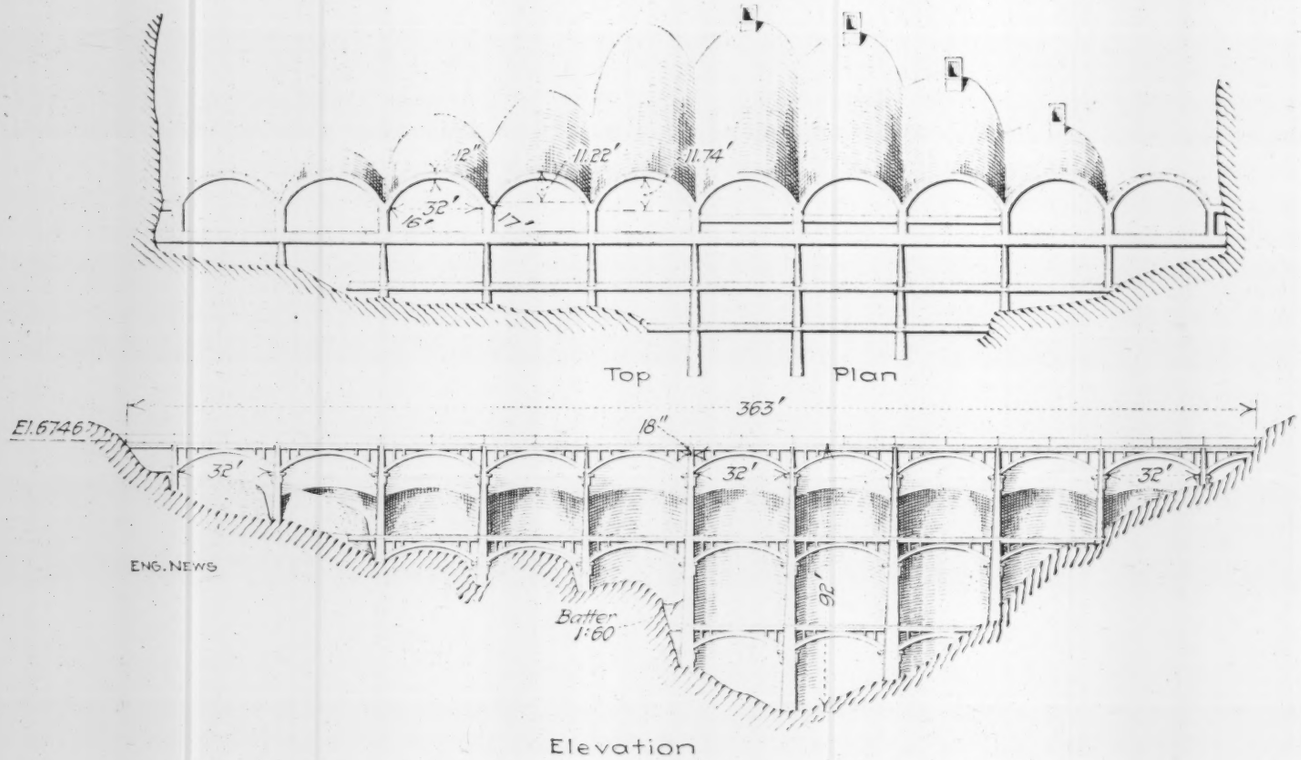


FIG. 3. PLAN AND REAR ELEVATION OF BIG BEAR VALLEY DAM, CALIFORNIA
(Multiple-arch concrete dam, designed by John S. Eastwood.)

ring, to which "ferro-inclave" sheets were clipped and used both as a concrete form for the outer face and a base for the plaster surface, as described further along in this article.

The spillway, owing to the large area of the reservoir and small drainage area and runoff, was placed at the ends of the structure, there being provided ten openings each 6.5x4 ft., and provided with flashboards, so that the whole of the opening can be closed to store water to the top of the dam, following the winter freshets. The water from the spillways will flow into a bowl-

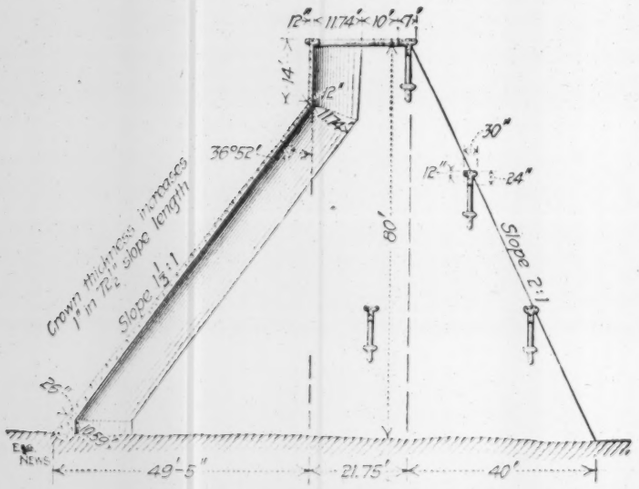


FIG. 4. TYPICAL SECTION THROUGH BIG BEAR VALLEY DAM NEAR DEEPEST PART OF GORGE

ter should occur after a preceding one with a full reservoir. However, no damage could be done were the water to flow over the entire crest of the dam, as it is all on solid bedrock foundation. The outlet works, owing to the small draft on the water-supply, which is an auxiliary supply, consists of four 12-in. openings. The water ends of these are screened by means of short pieces of railroad steel set vertically in concrete, two short pieces of pipe being set in each bellmouthed opening and passing through the arch wall to the gate pier on the under side of the dam.

The outlet gates are set about 10 ft. above the bottom of the reservoir and at the lower end of the pipes are placed a butterfly valve and a gate valve set tandem, an elbow of 90° being bolted to the flange of the valve gate, discharging the water downward through a section of steel pipe set in the gate pier. The water from this vertical pipe is discharged from the side of the pier through an elongated opening in the inside or toward the spring line of the arch of the dam, under the level of the water in the pool, which pool consists of the space between the two middle buttresses (Fig. 5). This method of discharge stills the water and it is taken out to the creek bed below over a Cippoletti weir where the water can be accurately measured as discharged. A well in the pool is provided for a gage measurement and also a well for a recording-gage float. A concrete footwalk provided with an iron gate leads from the rear to the gates, making in all one of the most complete and convenient outlet works possible to devise.

Construction

In 1894, ten years after the construction of the old dam, a foundation for a loose rock dam was laid and carried up a few feet, about 150 ft. downstream from the old dam, by Wm. Ham Hall, then the engineer of the company. This foundation occupied the only available site immediately below the old dam and had to be cut through in excavating for the new multiple-arch dam (Fig. 2). Meanwhile the winter freshets during 1909 and 1910, having leveled down the earthfill behind the old dam, filled the space between the old dam and the Hall base level fill, so that the excavation was very much increased at this site.

The construction was started by excavating through this fill to bedrock at each of the buttresses and along the line of the arches. On this solid rock stripped clean of dirt and left rough for bonding purposes, the concrete was laid. In order to roughen up the bedrock it was shot over from shallow drill holes.

The rock at the site is a very much fractured syenitic granite, the northern exposures being quite sound though very much fractured, while the southern exposures are decomposed to a considerable depth below the surface. The solid parts of the rocks lying in hard dikes, show the effects of the glacial action, while the decomposed portions consist of an overlying soil and gradually harden with depth. On account of the fractured condition of the rock at the ends and owing to the necessity of removing the base of the old dam from the channel, the excavation was quite a considerable depth over most of the area of the dam.

As much of the excavated material as would lie between the trenches was cast out, the balance being conveyed to the downstream side by means of derricks and the universal cableway carrying a flat skip.

The buttresses were built first, common rough boards being used for the forms, they were all carried up at the same time, thus allowing the alternation of concreting and form construction, on different parts of the work. The reinforcing rods to tie the arch rings to the buttresses were left protruding from the front edges of the buttresses, which were finished a short distance back of the spring lines of the intrados of the arch ring. All of the buttresses were built during the season of 1910 and stood till the spring of 1911.

The water face was then carried up as a whole, starting from the lowest place and keeping the work about level across the top. The forms for the under side were carried up to a considerable distance ahead of the outside forms and served as a working base for setting the reinforcement and for spacing the outside forms to give the required thickness of wall.

Fig. 5. Rear View of Dam
(Note strut members, pool and Cippoletti weir.)

Construction Plant

The construction plant consisted of a twin cableway, so arranged that the skip or other load could be taken to any part of the area of the base of the structure; a rock quarry from which the rock was conveyed to the stock bins by means of a cable lift for the empties and gravity return under drum brake for the loads; a rock-crushing plant; sand bins and sand-unloading device; a concrete mixer, air compressor and receiver, steam pump for

water-supply, flat cars for concrete buckets, carpenter shop and blacksmith shop.

The hoisting device was a universal cable system and was so arranged that any and all parts of the work could be reached by it. It consisted of two main track cables, each 2¼ in. in diameter, run across the gorge and anchored at both ends in the rock. At one end of each cable there was provided a turnbuckle takeup, so that the cables could be tightened to any desired degree. Upon these track cables were placed carriages, provided with two-track wheels, two wheels to prevent derailing from rebound, and two sheaves to take the hoisting lines. The universal movement was obtained by the use of two

FIG. 6. TOP OF FINISHED DAM

double-drum hoist engines and four lines by which all movements forward, back and across were made.

Machinery, boilers, cement, rock and earth, lumber for forms and the precast concrete members were all handled with this apparatus. Forms were hoisted, concrete buckets handled to place and finally the plastering was done from this skip.

The concrete plant was located in the bottom of the gorge, there being no room for it elsewhere. It was arranged so that all of the aggregate was brought to it by gravity, the sand and rock being run from measuring boxes to the charging hopper of the mixer. The mixer was a 9-cu.ft. batch mixer, discharging into the bottom dump 22-cu.ft. buckets, set on small flat cars running on a short spur of track, long enough to pass them out into the clear where the buckets were exchanged and the full one taken to place by the cableway.

FORMS—The forms were built of rough pine lumber hauled from a saw mill located in Holcomb Valley, about six miles from the site. It was delivered at the site at a cost of $28 per 1000 ft.

The buttress forms were built in sections 8 ft. high, consisting of 2x4-in. studs placed 2 ft. apart, set vertically, a cap being placed horizontally at each 8-ft. rise. The framework was first erected, after which 1-in. boards were nailed to the inside of this frame and held in place by means of spacing ties across the top and by stay wires and wooden struts between. The wooden struts were placed so as to be removed as the concrete reached them, the twisted wire ties remaining in the concrete and "X" bracing wires also being used to bring the forms to line and to give them lateral stiffness. The description of the forms will be of interest as tending to show how simple and light they may be built if they are properly braced.

The forms of the intrados of the arches were also of timber, built-up liners, made of 1-in. stuff, cut to the required curvature, were nailed together to form the bases for the studs, which were also 8 ft. long, the studs being nailed to the line of the outside of the liner and set radially, toenailed at the bottom and through nailed at the top. To these studs were nailed ½x6-in. boards bent to fit, doubled and lapped to make a tight form (Fig. 7).

This makes a surprisingly simple and light form for an arch centering, which is always thought of as very heavy with many supports. In this one there was no support other than the light liners, which were held by means of wire slings to the projecting reinforcement. At first thought it would seem that this form would sag and give way, but as the wall is carried up horizontally, the arch itself carries the load.

The outer forms were made of "ferro-inclave" set against angle-steel ribs, the ribs forming a reinforcement and support for the form, which was left in to give a base for the plaster coat and act both as form reinforcement and a water-tight film. The outer form was held away from the inner form by means of struts that were removed as the wall was carried up.

The forms for the beams and copings were made of 1-in. stuff held in place by means of brackets and ties across the top.

PLACING MATERIAL

The concrete for the buttresses was proportioned as a 1:2½:5 mix as nearly as possible and that for the water face was a 1:2:4 mix. In the buttress forms the concrete was laid in layers and well spaded away from the forms and was placed so as to keep the rear ends higher than the front. At the end of a pouring, stones were placed in the concrete for joining to the next succeeding work. Before concrete was poured on old surfaces, they were roughened with a pick, loose particles all being shoveled out, and the whole surface was then thoroughly scrubbed with a water jet under pressure, washing out all of the loose remaining materials. The surface was then sprinkled evenly with dry cement and the concrete immediately laid over it.

The concrete in the arch rings was more difficult to place, but it also was laid in layers, the thicker walls tamped on the inside, while the thin walls that were too small to allow a man to stand in them were tamped by means of taping the "ferro-inclave" forms, causing the concrete to settle down tightly to the forms. The tests and observations of the writer as to the efficacy of this method of making concrete dense were borne out by the resulting quality of the work placed by this method. In the case of walls, the tapping must be light and confined to the portions of the forms near the top of the concrete on the inside. Light wooden mallets were used for the purpose in this instance, but in later work where compressed air is available, short-stroke air hammers are specified for doing this work.

When the dam was entirely completed, there was placed on the "ferro-inclave" deck a cement wash coat, two coats of cement plaster and a wash coat over all. The plastering was done from the flat skip held in place by the conveying cable system, the workmen taking aboard

a supply of the raw materials and mixing the mortar as used on the platform.

Material

A quarry was opened in the hillside, in a hard dike above the south end of the dam, to supply the rock for the concrete aggregate. Air was conveyed from the air plant, which consisted of a steam-driven cross-compound compressor and a small air receiver, to the quarry, where it was used to run the hammer drills. Air was also piped to various parts of the foundations, where most of the drilling was done with it, using the hammer drills. The rock was broken in the quarry to the sizes required for the crusher and was conveyed by gravity to the rock crusher in side-dump cars of 36 cu.ft. capacity.

For crushing the rock for the aggregate a gyratory crusher was used, from which the crusher run was discharged into a stock bin, from which it was drawn into a measuring box, thence discharged into the charging hopper of the concrete mixer.

freight came by way of Santa Ana cañon at $30 per ton.

Wood was used for fuel for generating steam in the two hoisting-engine boilers and in the two stationary boilers used for generating steam for driving the rock and mixing plants and accessories. While surrounded by forests, wood was a very expensive fuel, owing to its low efficiency and the cost of its preparation. The timber consists of Jeffrey pine, which is very inferior for fuel and so knurly as to require powder to split it at all, often blowing a hole in a 4-ft. stick rather than splitting it.

For the hoisting engines the wood was hauled on wagons from the woods and for the boilers in the bottom of the gorge it was taken on barges and towed to the old dam and thrown over and wheeled to the boilers.

Costs

A comparison of costs and results is of interest as showing the status of the multiple-arch type of dam as compared to the old dam which was the lightest section

Fig. 7. Front View of Big Bear Valley Dam During Construction
(Note arch forms and reinforcement.)

The sand content of the concrete aggregate was gathered from the washes of the stream entering the lake, and was conveyed to the old dam by means of scows towed by motor boats. From the decks of scows it was loaded into a skip, made from a mining car body, hoisted over the old dam and dumped into the sand stock bin near the mixer. Sand was scarce and it required a good deal of care to get it in the quantities and of the quality required for the work.

It was possibly more costly than would have been a manufactured sand made from the granite rock at the site, though either way it would have been costly, owing to the high freight and fuel costs.

A local portland cement was used in the work and was tested at the mill. All of the material and supplies were hauled by wagons from Victorville, a distance of 55 miles and over a summit of 7600 ft. above sea level, with grades over 30% in places, the level parts of the road being in heavy desert sands. Part of the hauling cost was at $20 per ton and part at $25 per ton. During 1911 some

of masonry dam possible. The size of the dam is determined by the opening closed. The new dam is 363 ft. long on the crest, 63 ft. longer than the clear opening of the old dam, 92 ft. high, 31 ft. higher than the old dam (although its reservoir level is only 20 ft. higher than the old), hence the following comparative figures will be of interest:

OLD DAM (SINGLE-ARCH TYPE, STONE MASONRY)	
Contour of full reservoir (old datum)	51.25 ft.
Cost of structure	$125,000
Capacity of reservoir	7400 mil. gal.
Cost per mil. gal. capacity	$16.76

NEW DAM (MULTIPLE-ARCH TYPE, CONCRETE)	
Contour of full reservoir (old datum)	72 ft.
Cost of structure, less salvage	$133,528.42
Capacity of reservoir	22,880 mil. gal
Cost per mil. gal. capacity	$5.83
Total number of cu.yd. concrete	4684
Overall cost per cu.yd.	$28.51
Increase in capacity over old reservoir	309.2%

The ratio of efficiency of the old dam to the new dam is as 1 to 3.092, assuming the cost per unit of area of opening closed as being proportional to the total relative costs of the structures. As the additional 31 ft. of height is

in reality added to the base of the new dam, it will represent a much greater difference, the estimated cost of a single-arch dam for the same site being about double the cost of the multiple-arch dam.

The bulk of the material in the old dam was the granite rock on the ground, while the material for the new dam consists to a greater extent of material that had to be hauled to the site under the same difficult conditions.

The old dam has been much maligned, being condemned by experts in sentiment and psychology as being dangerous on account of its slender looks, while in fact, when the stresses are computed in the light of more recent investigations, it is found to be a very substantial dam, and much respect is due to the builder, F. E. Brown, of Los Angeles. The old dam has a factor of safety against crushing of 7.5, allowing the crushing strength of granite to be 4000 lb. per sq.in. The new dam has a like safety factor of 13.5, allowing the ultimate crushing strength of concrete to be 3000 lb. per sq.in.

The multiple-arch design of dam is an amplification of the arch principle in structural dam design, in which advantage is taken of the water pressure to assist the weight of the structure to get the required stability. There are no other than compressive stresses in the multiple-arch dam, when the loading, as in the present case, is moderate in amount, the nearest to a tensile stress being that due to the bending due to rib shortening, at the spring lines of the extrados and at the crown line of the intrados, but these eccentric loadings, owing to the light unit loadings adopted, are well within the requirements of good practice.

The accompanying views of the dam in service (Figs. 2, 5 and 6) were taken in June, 1913, at which time the writer made a careful inspection of the dam. It was gratifying to learn that there was to be found no visible crack in the entire structure, and that the walls were practically water-tight throughout, the slight leakage showing being through the seams of the bedrock, which seams have not yet silted tight, owing to the clear condition of the water.

Owing to the short seasons at this altitude, it required two summer seasons to complete the dam. It was impossible to get over the roads with loads earlier than about June, as one passed over a summit of 7800 ft. and the other 8200 ft. above sea level and the roads were closed after October.

Personnel

The New Big Bear Valley Dam was designed and built by the writer for the Bear Valley Mutual Water Co., of which the stockholders are the users of the water stored in the reservoir. This company took over the properties of the Bear Valley Irrigation Co., which owned the old dam. The dam is now in satisfactory service.

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A Public-Service Commission for Illinois is to be appointed by Governor E. F. Dunne under a law recently passed, and the Illinois Society of Engineers and Surveyors has petitioned the governor to appoint as one member of the commission an engineer experienced in the design, construction and operation of public utilities. It is pointed out that this commission will have to adjust rates and deal with problems involving the operation of water-works, power plants, railways and other public utilities, and that technical knowledge of and experience with such engineering works is essential to enable the commission to act with efficiency to the state and equity to the corporations.

The Application of the Flow-Summation Curve to Problems of Stream Regulation and Storage

By E. Clinton Jansen*

In hydro-electric work, the storage and regulation of stream-flow are often subjects of considerable importance and in the investigation of these matters, engineers are frequently confronted with problems such as the following:

(1) Having a certain reservoir capacity and the mean daily discharges of a stream for a period of years, what is the maximum regulated flow which can be obtained for power purposes?

(2) Having the mean daily discharges of a stream, how large a reservoir is required to obtain a maximum regulated flow?

(3) Having the mean daily discharges of a stream, a certain portion of which is already appropriated for direct use for irrigation, how much of the stream-flow is available as storage for water-power purposes?

The writer has frequently had to solve such problems and in doing so he has always applied the flow-summation curve with much success. The curve itself, needless to say, is not a new idea, but the writer believes that its value is not generally appreciated by hydraulic engineers and that it could be applied to advantage more often than it is at present.

Where the annual runoff of a stream is extremely variable and storage water is carried over in a reservoir from one year to the next, such questions as enumerated, can only be solved by a cut-and-try method and before the advent of the summation curve this necessitated a great deal of tiresome figuring. With a summation curve, however, although the method is still a cut-and-try one, the problems can be solved almost at a glance.

The elements of the curve are simple enough. To plot the stream-flow for any period of time, for instance, the mean daily discharges in any convenient unit are added day by day and plotted as ordinates, the units of time being represented by abscissas, so that the sum total or ordinate on any date represents the total quantity of water which has flowed past the gaging station up to that date (see curve *ABCDE*, Fig. 1). Second-feet (cubic feet per second) are now most commonly used as units of flow and, when the mean daily discharges are expressed as such, the summation of them furnishes us with convenient units of day-second-feet or a second-foot flowing for twenty-four hours (1.98 acre-feet) as in Fig. 1. As the length of the ordinates shows the increase or decrease of the 24-hour flow, it will readily be seen that the *slope* of the curve represents the rate of flow and that a uniform flow is represented by a straight line as *FG*, Fig. 1.

Let us assume for example that *FG* represents a regulated or uniform rate of flow of 30 sec.-ft., then by applying this slope as a tangent to the summation curve at *C*, we observe that the stream from about Oct. 1, began to discharge less than this flow and did not rise above the same until the beginning of April at *D*. The flow can be readily interpreted in this way by drawing a datum and different slopes or tangents on a piece of

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acing linen and applying this at any point on the ve.

Fig. 1 shows the application of the summation curve to the first storage problem stated above. $ABCDE$ represents the stream-flow in day-second-feet (usually a period of minimum runoff when water-power is contemplated); FG is the desired regulated flow and H is the capacity of the reservoir in day-second-feet. Starting with a full reservoir on or about Oct. 10, 1895 (the smaller units of time are purposely omitted), our summation curve shows us that the stream-flow is below the desired regulated flow AB_1, parallel to FG, and that the ordinates JK, LM, etc., represent the amounts of storage required to maintain the regulation. Plotting these ordinates below the high-water level of the reservoir in the storage diagram as J_1K_1, L_1M_1, etc., we obtain our storage curve $H_1J_1L_1$, showing the behavior of the reservoir during the uniform rate of discharge for power purposes. At B, about Apr. 10, 1896, the summation curve shows that the stream-flow is above the desired regulated flow; consequently, the ordinates NO, PQ, etc., show the amount of water which can be stored and these ordinates are plotted as N_1O_1, P_1Q_1, etc., for the remaining portion of the storage curve until the reservoir fills about June 1. By continuing the plotting of these ordinates RS, TU, etc., as R_1S_1, T_1U_1, etc., in the storage diagram, we get the curve $S_1U_1W_1$, showing the quantity of water which passes over the reservoir spillway. This process is then repeated and in this way we ascertain the behavior of the reservoir from year to year while a continuous draft is being made on it. The ordinate X, showing the water left in the reservoir at the end of the drawing period, enables us to experiment with different regulated flows to ascertain just how much draft the reservoir can stand. Frequently two or three exceptionally dry years in succession in a long period of observation will tax the reservoir capacity to its limit and settle the question conclusively as to the maximum regulated flow obtainable.

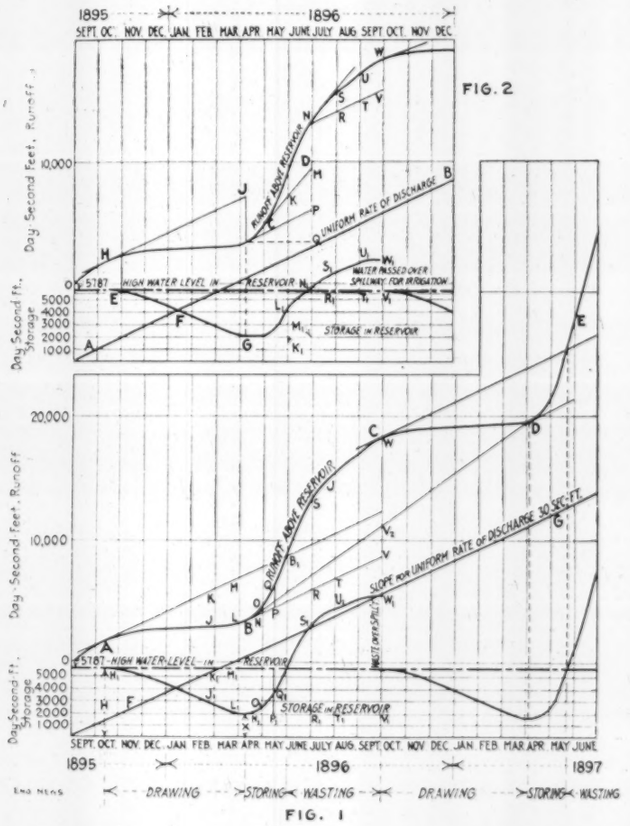


FIG. 1

In regard to the second problem previously referred to, if we draw a line from B to D, we obtain the maximum regulated flow using all the water and the ordinate V_2W represents the capacity of the reservoir in day-second-feet, which would be required to effect this.

Fig. 2 shows how the summation curve can be applied in the solution of the third problem, when a regulated flow AB is required for power purposes and a portion of the stream-flow CD is appropriated for direct use for irrigation purposes in April, May and June, below the power plant.

To ascertain the water available for storage in this case, we obtain our curve EFG by plotting the ordinates between HJ and the summation curve as previously explained. From about Apr. 10 to May 1, our runoff curve shows that the entire stream-flow will be used for irrigation and, consequently, the water level of our reservoir is standing still. After the latter date we are able to store the water represented by ordinates KL, MN, which, plotted as K_1L_1, M_1N_1, gives us our curve for filling, L_1N_1. PM shows the total quantity of water released from the reservoir for irrigation during this period in addition to our tail-race water QP. By continuing the plotting of ordinates RS, TU, as R_1S_1, T_1U_1 in our storage diagram, we obtain the curve $N_1S_1U_1$, which shows the water which passes over our spillway for irrigation purposes. This is, of course, in addition to our tail-race water from the regulated flow which would probably be used as well for irrigation.

FIG. 2

The interpretation of the curve to a beginner may at first be puzzling but, once one is familiar with its characteristics, the plotting of the ordinates for a storage diagram takes but a few minutes and results are quickly obtained. The rate of regulated flow desired is usually increased sufficiently to cover loss by evaporation and seepage in the reservoir. To obtain accurate results, all summation curves should be plotted to as large a scale and as flat as possible so that the point of tangent for slopes of different rates of flow can be readily detected.

When an investigation is made covering a number of years, it is convenient to plot the summation curve of each year's runoff on the same datum and not in one curve as in Figs. 1 and 2.

A New Automatic Fire Alarm Device is described by F. A. J. Fitzgerald in the November "Journal" of the Franklin Institute. The apparatus includes a thermoscope in which the active element is silver sulphide, which has a negative temperature coefficient of electrical resistance. To eliminate polarization, alternating current must be used. An electric circuit, in which the thermoscope and an alarm gong and indicating device are connected, has such a high resistance under normal conditions that the current passing through the circuit is not sufficient to work the alarm. Should, however, the temperature of the air surrounding the thermoscope rise to a certain degree, the electrical resistance drops to a value which permits the passage of sufficient current to operate the alarm.

Before being placed in service, the apparatus is tested in the following manner. A cone made of asbestos board is moistened with about 50 c.c. of alcohol and placed on the floor under the thermoscope and ignited. The resulting heat should be sufficient to give the alarm, although a dial thermometer mounted beside the thermoscope shows a rise of but 5° C. The device is the invention of Eugene Garrison and is manufactured by the General Fire Alarm Corporation.

Hypochlorite Disinfection of Sewage at Providence, R. I.

For the past two or three years, the sewage works of Providence, R. I., which were originally built and operated for chemical precipitation, have been operated as plain sedimentation tanks, with hypochlorite disinfection. We are indebted to Otis F. Clapp, city engineer, of Providence, for an advance copy of a summary of the work of the plant during 1912 which summary was prepared for his annual report for 1912, not yet published.

There was treated during 1912 a total of 8,248,000,000 gal. of sewage and storm water, or an average of 28,535,000 gal. per day. Hypochlorite was added at the rate of 144 lb. per 1,000,000 gal. or 5.76 parts of available chlorine to 1,000,000 parts of sewage. The sludge from the settling tanks was pressed. The operating cost of sedimentation and disinfection was $2.85 per 1,000,000 gal., and of sludge disposal $2.49 more, making a total of $5.34 for sewage treatment, not counting capital charges.

The detailed summary for the year 1912 is as follows:

Population in 1912, 235,600; served by sewers, 206,000.

Length of sewerage system in miles: Combined, 229.881; storm, 13.838.

Character of the sewage: Manufacturing wastes from woolen mills, bleacheries, dye-houses and jewelry factories, with domestic sewage.

Total amount of sewage passing through plant during year: 8329 million gallons.

Storm water discharged without treatment: 81 million gallons.

Hours of storm water: 39.

Amount of sewage treated during year: 8248 million gallons.

Daily flow of sewage, in million gallons:

Maximum, Dec. 27	47.709
Minimum, Dec. 16	none
Average for year	22.757
Average flow treated	22.535

Cubic contents of tanks, up to flow line, in million gallons: Settling tanks, 3.96; storage tanks, 7.17.

Disposition of effluent: During the flood tide, the effluent from the settling tanks is run into the storage tanks; during the ebb tide the effluent from the settling tanks is discharged directly into the river, together with the amount stored during the flood tide.

Chemicals used (tons): Hypochlorite for disinfection, 595.0; lime added to sludge, 572.5.

Pounds of hypochlorite added per million gallons of sewage treated: 144.

Parts available chlorine added per million parts of sewage: 5.76.

Method of sludge disposal: Pressed, and cake carried away on scow.

Description of machinery used: Sludge pumped by Shone ejectors (two 500 gal.) to storage reservoirs; thence by gravity to forcing receivers (four, 8 ft. dia. x 12 ft. long); thence forced under 60 to 80 lb. pressure per sq.in. up into the presses. The ejectors and forcing receivers are run by air-pressure generated by one 150- and one 50-hp. air compressor, actuated by electric motors; 18 filter presses are used, each with from 43 to 54 plates with 6-in. center holes, forming cakes 36 in. square and from 1¼ in. to ¾ in. thick, between filter cloths which surround the plates.

Amount of sludge produced: 14,503 million gallons.

Gallons of sludge produced per million gallons treated: 1758.

Pounds of lime added per thousand gallons of sludge: 79.

Per cent. of solids in wet sludge: 9.97.

Amount of sludge pressed: 11,089 million gallons.

Amount of water removed by sedimentation of sludge in reservoir: 3,414 million gallons, or 23.5%.

Tons of sludge cake produced: 20,436.

Tons of sludge cake produced per day: 55.84.

Per cent. of solids in pressed cake: 29.5.

Tons of solids produced per day: 16.47.

Cost of sedimentation and disinfection per million gallons of sewage treated: $2.85.

Cost of sludge disposal per million gallons of sewage treated: $2.49.

Cost of sludge disposal per ton of solids: $3.41.

The efficiency of disinfection, based on the relative numbers of B. coli in the sewage and in the effluent, was 97.1%. The records of chemical and bacterial analyses for 1912 will be summarized in the report as shown by the accompanying table.

SUMMARY OF RESULTS OF SEDIMENTATION AND DISINFECTION OF THE SEWAGE OF PROVIDENCE, R. I.

Chemical analysis (parts per million)

Solids	Sewage	Effluent	Parts removed	Per cent removed
Total	1145	1030	115	10.04
Soluble	858	880	—22	—2.56
Suspended	287	150	137	47.72
Non-settling*	980	1005	—24	2.45
Settling*	165	26	139	84.24
Albuminoid ammonia:				
Total	9.20	6.65	2.55	27.71
Soluble	3.91	3.53	0.38	9.72
Suspended	5.29	3.12	2.17	41.02
Non-settling*	6.68	6.27	0.41	6.14
Settling*	2.52	0.38	2.14	84.92

BACTERIAL RESULTS

	Hypochlorite used (parts available chlorine per million parts of sewage.)	Per cent. removed: Total bacteria (on agar, at 37½° C.)	Per cent. removed: B. Coli. dac-toss bile, at 37½° C.)
January	5.34	98.2	99.1
February	5.36	96.8	99.4
March	3.41	92.4	97.1
April	3.90	99.2	94.3
May	5.26	99.9	97.3
June	7.07	93.3	98.0
July	7.70	70.6	95.1
August	8.25	59.9	98.8
September	8.46	70.2	96.2
October	7.41	66.7	99.1
November	5.23	71.7	98.3
December	4.25	71.3	98.5

* In 4 hours.

Julius W. Bugbee is chemist and superintendent of the sewage works.

Report on Flood Protection for Troy, O.

The flood effects at Troy, Ohio, in the great floods of last March were briefly described in ENGINEERING NEWS, May 1, 1913, p. 925. Sixteen lives were lost at Troy. The situation was largely determined by a strip of low ground in the west part of the city, over which part of the river flow went, leaving the unsubmerged part of the city on an island in the flood. A report on possible flood protection work at Troy by the Morgan Engineering Co., of Memphis, Tenn., deals largely with protection of this westerly low area. The report is notable because it shows that the city can be protected against floods equal to that of last March at a remarkably low cost—a total not far above $50,000.

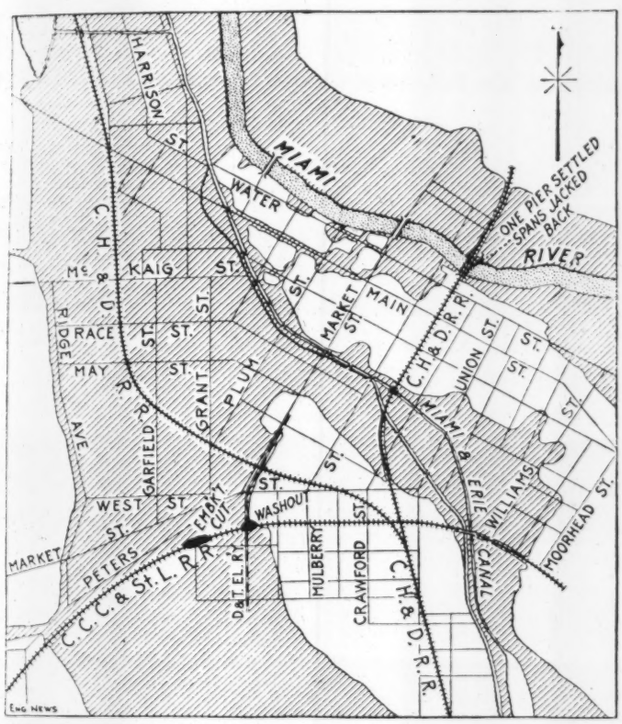
The map in our issue of May 13, p. 926, showing the flooded area in Troy, is reproduced herewith. By referring to this map (Fig. 1), the proposed protection work may be located. A larger area is shown in Fig. 2, one of the Morgan Engineering Co.'s maps illustrating the situation.

The maximum discharge of the Miami at Troy in the flood of last March is estimated by the engineers at 100,000 cu.ft. per sec. The drainage area tributary is about 900 sq.mi., making the flood flow about 110 cu.ft. per sec. per sq.mi. of drainage area. Of the total flow, 70% is estimated to have passed down the main channel of the river while 30,000 cu.ft. per sec. cut off across the low ground in the western part of the city. The river channel was sufficiently obstructed by the bridge of the Cincinnati, Hamilton & Dayton R.R. that a head of 3 ft. was created at the bridge. The property damage is not stated. Sixteen lives were lost in the flood.

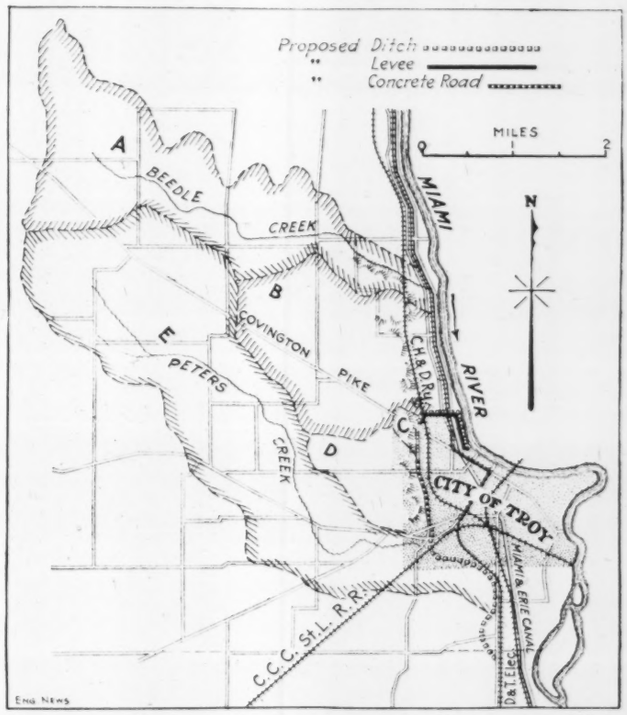
While the flood of last March was of unprecedented

...ress, and while flooding due to high water in the Miami River is in general the more serious, damage due to excessive discharge from the smaller hillside streams flowing in from the West at Troy (drainage areas *A* to *E*, Fig. 2) is much more frequent, and therefore the proposed protective works relate in part to protection against these streams. The Miami & Erie Canal, located on a slight ridge west of the river, cuts off most of their drainage and diverts their floods southward into the city.

Rapid runoff is characteristic of the country around Troy. The general slope of the upland toward the river is 10 to 20 ft. per mile, while the slopes toward the minor streams are 20 to 100 ft. per mile. Further, the soil is hard clay and gravel, and marshy areas have been well drained by ditches. It is estimated that water from the



FLOOD MAP OF TROY, OHIO
(Reproduced from "Engineering News," May 1, 1913.)



FLOOD-PROTECTION WORKS FOR TROY, AGAINST MIAMI FLOODS AND UPLAND CREEKS

most distant parts of the drainage area reaches the city within three hours after its fall.

The following protective works are proposed:

1. DITCH AND LEVEE—A levee, with a drainage ditch at its upstream side, is to be constructed near the north boundary of the city (practically in line of the street shown at the top of the map, Fig. 1, and west of the Miami & Erie Canal), from the high ground west of the city, crossing and closing the canal, and continuing southerly along the eastern bank of the canal to a point near the bend of the river, i.e., near the northwesterly end of the higher ground, unsubmerged in the March flood. The ditch will also extend eastward to a direct discharge into the river, its purpose being to carry the upland drainage north of the levee.

The levee and ditch will completely protect the westerly low part of the city against Miami River floods and water from areas *A* and *B*, Fig. 2. To protect the area near the river in the easterly part of the city it will be necessary to build a concrete wall along the right bank, south to the city limits. The engineers do not recommend building this wall at present.

The levee is to have a top width of 8 ft. and side slopes of 2 to 1. Its crest is to be 7 ft. above the high-water level of March, 1913. The soil available locally resists erosion well; levees and canal banks were scarcely harmed at all by the last flood except where they were actually overtopped, though many of them have side slopes steeper than 1½ to 1.

The cost of the levee and ditch, including raising of grades, is set at $40,000.

The concrete wall, when built, should have its top 3 to 7 ft. above the river bank, to have 2 ft. margin above the flood of last March. The cost, $150,000 to $300,000, will depend upon right-of-way possibilities.

2. WEST DRAIN—To intercept the flood flow of the minor streams south of the levee, a drain is proposed running south along the foot of the upland in the west part of the city. The existing tile sewers are wholly inadequate. A covered concrete drain would cost $48,000. The finally selected plan is to pave with concrete the street running along the foot of the hill (Ridge Ave.), and let this act as a flume for the floodwaters. Ordinary rains would be taken care of by the gutter of this road, and in very severe rains the whole width of the street would carry water. Up to the overflow point this road could carry a runoff of 2 in. per hr. on the entire tributary drainage area.

This road-flume protects against the storm runoff of area *D*, Fig. 2, which has always been one of the most troublesome to the city. Area *C* is left unprovided for, the cost of extending the road being disproportionate to the small size of the drainage area, 50 acres.

3. DREDGED DITCH—The south end of the concrete road will discharge into an open ditch leading southeast-

ward to the river. The ditch is to dredged. It takes care of the drainage from area *E*, 47,000 acres, in addition to the flow from the concrete road.

An organization is being created to carry out all of the improvements proposed, the river wall being omitted for the present on the engineers' recommendation. Should a system of flood-preventive storage reservoirs be built to protect the Miami valley as a whole, the concrete wall would not be needed.

❖

Two Large Concrete Arches on a Swiss Mountain Railway

A narrow-gage electric railway now being built between Chur and Arosa, in Switzerland, is a notable example of the bold and elaborate character of construction required in mountain-railway work. Retaining walls, bridges and snowsheds are used in great abundance and variety. Most remarkable, however, is the inclusion among the bridges of two reinforced-concrete arch bridges which rank among the three or four largest hitherto built.

The Langwies arch, with a clear span* of 314.9 ft., rise (c. to c.) of 137.8 ft., and a crown height of 203.4 ft. above the valley, is the more important of the two. It is but 13 ft. shorter in span than the largest concrete arch in the world, the Risorgimento Bridge over the Tiber at Rome, Italy, and 5 ft. shorter than the Grafton, N. Z., arch; and by reason of its height and excellent structural arrangement, it deserves to be placed ahead of the former and be classed second to the Grafton arch. The Gründje-tobel bridge has a much flatter arch span of 282 ft. (c. to c., the clear span not being stated). This, it will be recalled, is slightly in excess of the span of the [illegible]ky River arch in Cleveland, which but a few years ag[illegible] for a short time held the record of being the largest [illegible] the world.

We are able to show herewith, from an article by G. Bener in "Schweizerische Bauzeitung" of Nov. 22, 1913, a view of each of these two structures in course of erection, exhibiting not only the large arch spans but also the nature of the centering construction. Attention is called to the differences between the two, due in part to the differences in proportions of the two arches and in part to the lay of the land under the arch. The Langwies bridge crosses two brooks, which join just below the bridge, and the natural place for support of the centering was at mid-span.

Reinforced-concrete tower framework was used for the lower part of the centering in the Langwies arch. This radical novelty had its motive partly in the desire for greater rigidity in centering and greater security against settlement, and partly in the supply of material and the design of the centering itself. It will be noticed that the middle support is in effect a four-bent tower containing eight posts, braced in both directions. The supports under the haunches are single-bent, each of two posts. The height of the supports is 72 ft. above water level.

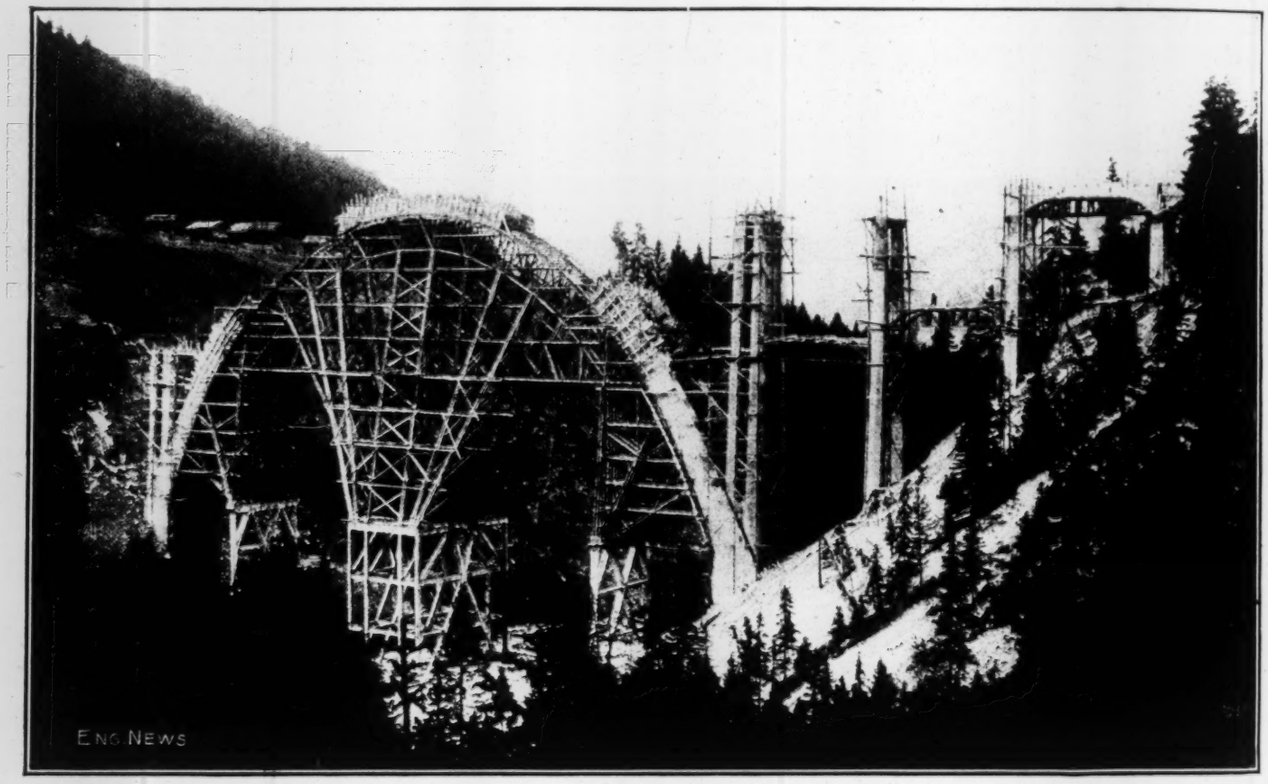


FIG. 1. THE 315-FT. LANGWIES ARCH

The smaller Gründje-tobel arch was closed on Sept. 15, 1913, foundation work having begun on June 25, 1913. The Langwies arch was begun late in 1912. The concrete centering-support was built in spring of 1913, but further construction was delayed on account of difficulties in getting a satisfactory foundation at one abutment. On Sept. 6, 1913, the falsework was completed, and on Oct. 6 both ribs had been concreted except for closure of the joints.

An interesting difference of treatment of the concrete

*Our previous information ("Eng. News," Aug. 7, 1913, p. 269) that the span is 330 ft., was in error.

...terizes the two bridges. The Langwies arch was ... of dry or moist concrete, rammed to place, as fav... by older practice in Europe. The other bridge has ...oncrete wetter, and may properly be called poured ...rete, which is the character of mixture used in most ...inforced-concrete building work in Europe at the pres... time.

Why "Safety First" is Sound Economy

By Alexander Haring*

The B——— Company was erecting a mill in New Bedford. To hoist lumber to the upper stories they secured and duly installed a hoisting engine from H—— Bros. Soap Works.

testified he, "I had in the neighborhood of 20-ft., 4-in. planks, 6 in. wide. I picked up my load and, as I went to change ends, she got away from me and backed down. I informed the superintendent that I believed the piston-rings were worn. Later, I took the heads off, examined the rings, and found this to be the case."

When asked what was done about it, Ryan replied:

"I did not have the rings fixed, I informed the superintendent and we doubled up on the purchase; we had double blocks on the boom and doubled on the hoist, to make it easier on the engine."

So this engine, known by the engineers and their superiors to be in bad condition, was shipped to the job and put in operation. Beside the piston-rings, the friction-levers and the foot-brakes were out of order—matters which a small expenditure of money would have rem-

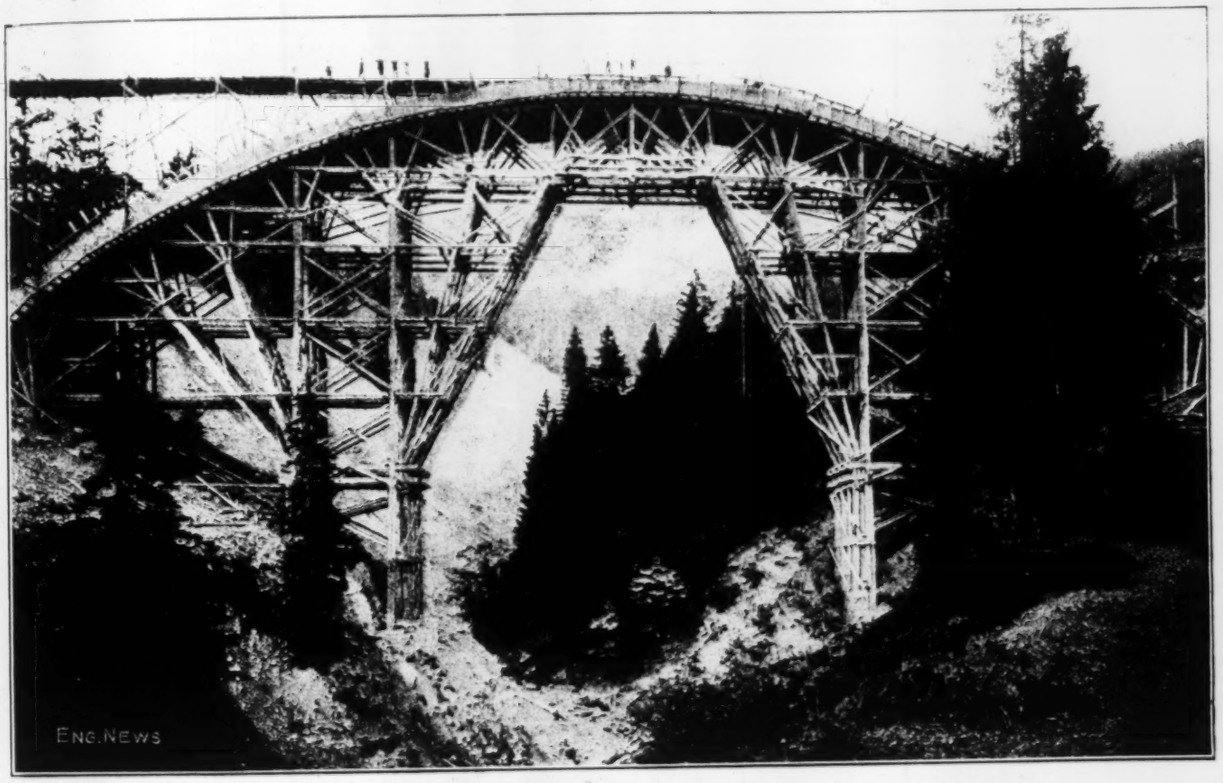


Fig. 2. The Gründje-Tobel Bridge, Chur-Arosa Railway, Switzerland

One morning Laplant, a new hand, was assigned to the gang of Jack Donovan, the derrick foreman. A load of lumber arrived and Laplant, under Donovan's direction, put the sling around it, made a hitch, and the signal was given to hoist. The load didn't exactly balance, so it was lowered and the sling adjusted. This happened a second time, and as the load was again being lowered for adjustment, the 6-ton load of lumber fell, struck the wagon, slipped the sling off the hook, and divided, half of it toppling over on Laplant, killing him instantly.

This particular hoisting engine, it appeared, had been used on construction work, and had been found defective. Thomas Ryan, the engineer at the soap factory, discovered that it would not hoist a heavy load and, in order to use it at all, divided the loads and hoisted them piecemeal.

"The first time I ran this engine at the soap works," ...

*Counselor at Law, 165 Broadway, New York City.

edied. But the policy of "economy" prevailed, and some months later the poor performance of the hoisting engine coupled with a careless hitch of the sling cost, not only the life of a man, but $3000 in damages to his employer.

The damages which may result from a given failure to maintain a machine in proper condition are so fluctuating that it is impossible to establish a working ratio between the cost of adequate maintenance and the damages from an action at law. The parties in interest do not consciously make any comparison of figures to ascertain if it is a wise economy to postpone the repairs and take a chance of accident. The latter is not given much fair thought; in fact, the owner generally contents himself with the paying of a liability insurance premium. If he does not take the precaution so to provide himself, he may then have damages awarded by the jury, his attorney and witnesses to pay and the loss of time of em-

ployees while in court; and, in addition, the engine must be repaired or replaced.

The failure to keep machinery in repair results in losses which are difficult to gage, such as diminished output, destruction of material, and waste of operator's time. A saw which does not cut well or a boiler which does not supply sufficient steam may be the first step in cutting down the percentage of efficiency. Material which is poorly wrought by a lame machine may be ruined for any purpose or, at best, it must be relegated to second-grade goods. The time of the operator, if well spent, will be upon production and not upon tinkering. The losses are more or less continual and are not easily measured.

But what of the monetary loss resulting from accidents on a defective machine or tool? It cannot be counted on with any regularity; an accident may occur today, or tomorrow, or never. Here is where the owner takes a chance, which in the case of Laplant, cost him $3000.

Similar failings in business procedure are illustrated in a happening on the construction work of the Catskill Aqueduct. A contracting concern had a portion of the tunnel to excavate. In doing this particular work it was necessary first to sink a vertical shaft 125 ft. deep and then, from the bottom, excavate horizontal tunnels in opposite directions. In the shaft were placed two elevators, operated by a hoisting engine on the surface. They were designed for reverse operation, the ascending cage usually carrying a car loaded with earth while the descending cage carried the empty car. At the bottom of this shaft it was necessary for a man to run the cars into the cage and signal for the hoist.

The signal on the surface consisted of a large triangle similar to those used in brass bands, suspended from a wooden framework and rung by striking with a wooden lever. Fastened to one end of this lever was a signal rope, which was run down the shaft. The signal at the bottom of the shaft was a tomato can hung on the same rope and operated from above.

In the Labor Law of the State of New York, there is a section which says that around the bottom of a shaft there shall be a space cut out of the solid material (whether it be earth or rock), not less than five feet high and three feet wide, to enable workmen to pass around the cages, without being obliged to walk under them. In this instance there was such a space, but much smaller than that called for by the law, partially filled with pipes. It was so small, in fact, that a man had to twist and squirm in order to get through.

A laborer named Fogarty, whose duty it was to give signals and to switch the cars at the bottom of the shaft, was on the night shift. One evening before reporting for work he had a glass of beer with his gang foreman in a village saloon, then walked three miles to the shaft. He went down in one of the cages with his gang and relieved the man on duty, pushed the empty cars to the switch in the tunnel and brought the loaded ones to the elevator. As he passed through the pit to reach the signal rope on the other side he was knocked down by a descending cage and severely injured.

It cost the contracting company, or their liability insurance company, approximately $2100 plus attorneys' fees for this bit of economy in excavation and in signaling apparatus. By a liberal estimate, $25 would have covered the expense necessary to make the excavation specified by law; while $5 more would have provided suitable electric bells for signaling purposes.

Penny wise and pound foolish seems to characterize this method of business procedure, yet contractors often take the chance. The fact that they sometimes "get away with it" strengthens their habit of running the risk. But on which side of the profit and loss account is the balance in the long run? To use approximate figures in this particular case, the contractor if successful in his gamble, saved, say $30; to lose cost him $2100. To come out even with the game, he would have to escape accident seventy times to make up for this single disaster.

A Sieve Test for Cement that Insures Uniformity in Fineness

By G. J. Griesenauer*

Every cement tester realizes the difficulty of being able to check-test previous fineness tests made with No. 200 sieves. He prepares a sample of cement carefully by first screening it through a No. 20 screen, which removes all coarse lumps and flint pebble fragments and large clinker, if there are any of these in the sample. The sample is then thoroughly mixed, and also generally dried. With such a carefully prepared sample it is reasonable to expect to be able to make a number of fineness tests with a 200-mesh sieve which would show a uniformity in the results obtained when the time of sieving is constant. It is disconcerting when he finds that these results are not uniform, but often show a considerable variation.

This being the actual case when comparing the results of his own tests, he wonders less that other tester's results and his results do not compare, even when the same sieve and the same cement from the sample lot is used and the same amount of time is allotted to the making of the test.

Such variations are attributed to "personal equation," but how is he to account for his own variation in results? It is not due to any irregularity of the sample, for that has been thoroughly prepared to perfect uniformity. He employed exactly the same amount of time in making each test, so it cannot be due to any difference in duration of time employed. He feels absolutely sure that none of the residue slopped over the rim of the standardized sieve, a blame generally and quickly given when two operators obtain different results on a single sample with the same sieve.

No satisfactory answer has yet been given, so far as I have been able to find. This has puzzled many investigators, and has been disappointing and discouraging to many who have striven to bring about closer uniformity by exercising the utmost care in making this test.

At present the U. S. Bureau of Standards allows a tolerance of 1%; that is, different 200-mesh standardized sieves using cement from the same sample lot, may show a maximum variation of 1% between results obtained with such sieves.

Recently it has been found in the cement-testing laboratory conducted by the Engineering Department of the

*Cement Tester, Engineering Dept., Chicago, Milwaukee & St. Paul Ry., Chicago.

Chicago, Milwaukee & St. Paul Ry. Co., of which C. F. Loweth is Chief Engineer, and L. D. Hadwen is Engineer of Masonry Construction, that the results are materially affected by the position of the warp and the shoot wires with reference to the motion of the cement sample across them. The accompanying table shows the effect briefly:

Variation in results due to method of making the fineness test of cement as regards warp and shoot (woof) wires. No. 200 Mesh U. S. Bureau of Standards Standardized Sieves. Fineness tests of 15 minutes duration, using cement from one sample lot.

Sieve	No. 1	No. 2	No. 3	No. 4	No. 5
Tests made across warp wires.	80.24%	81.21%	81.66%	81.70%	81.79%
Tests made across shoot wires	78.86%	80.30%	80.79%	81.11%	80.99%
Difference between warp and shoot tests.....	1.38%	0.91%	0.87%	0.59%	0.80%

Note—The above figures are the averages of several tests with each sieve, all practically uniform, the maximum variation being 0.15%.
Greatest variation in above tests, warp wires, 1.55% (81.97%—80.24%).
Greatest variation in above tests, shoot wires, 2.13% (80.99%—78.86%).
Greatest variation between warp and shoot wire tests, 2.93% (81.79%—78.86%).

It will be noted in this table that the greatest variation between tests across warp wires and across shoot wires is sieve No. 1, which amounts to 1.38%. This sieve shows 80.24% across warp wires and sieve No. 5 shows 81.79%, a difference of 1.55%, and across shoot wires No. 1 shows 78.86% and No. 5 shows 80.99%, a difference of 2.13%. Comparing No. 1 sieve's 80.24% (across warp wires) with No. 5 sieve's 80.99% (across shoot wires) we find a difference of 0.75%. But comparing No. 1 sieve's 78.86% (across shoot wires) with No. 5 sieve's 81.79% (across warp wires), we find a difference of 2.93%.

Assuming that sieve No. 5 showed a difference of 1.38% between warp- and shoot-wire tests, as does No. 1, and that the 1% tolerance that the U. S. Bureau of Standards allows existed between the warp-wire test of No. 1 (80.24%) and the shoot-wire test of No. 5 (which could then be 81.24%) we would have 78.86% for the shoot-wire test of No. 1 (80.24% − 1.38% = 78.86%), and 82.62% for the warp-wire test of No. 5 (81.24% + 1.38% = 82.62%), or a difference of 3.76%.

It may be argued that warp-wire results cannot be fairly compared with shoot-wire results, but these comparisons are made to show what variations are entirely possible with most carefully made tests if the effect of testing across warp and shoot wires is neglected.

It should also be kept in mind that the above data are compiled from the results of only five Bureau of Standards sieves, which are all that I have had an opportunity to use for this series of comparisons. It is possible that these five sieves represent the maximum variation of sieves standardized by the Bureau of Standards. But it is also more probable that the maximum might be found to be even greater among the large number of standardized sieves that the Bureau has tested and approved. The complaint of a variation of as high as 5% here comes to mind, and does not look so improbable.

Other tests were made to substantiate the correctness of this marked difference obtained between tests across warp and shoot wires. For instance, a number of unstandardized sieves were used; tests employing different periods of time for different series of tests; also using a 100-mesh sieve. All of these results harmonized with those given, and are not included here, as they would be mere duplications, so far as the relative effect due to way of holding the sieve is concerned.

It should be remarked here that, as expected, the 100-mesh sieve showed considerably less variation between the results of tests across warp wires and across shoot wires. It is probable, therefore, that sieves finer than the 200-mesh sieve would show a correspondingly greater variation between results obtained across warp and shoot wires.

The question of the effect of holding the sieve in a position so that the cement sample passed over the cloth at a diagonal angle of both warp and shoot wires was also looked into, and it was found to range half way between the results of that obtained by the right angle to warp and to shoot wires.

A revolving motion also produced higher results than obtained across the shoot wires. But this method would conflict with the standard specifications, which require the sieve to be "held in one hand . . . and moved forward and backward . . . at the same time striking the side gently . . . against the palm of the other hand . . ." This allows of no such circular motion. Besides, the speed of 200 strokes per minute could not be reached and maintained with that additional motion adopted, which would again depart from the specifications and also change the point when the operation should stop.

All of these tests were made from one carefully prepared sample lot of cement, and in a short period of time. Aging cement increases the fineness, which is due to the gradual disintegration of the coarser particles, even when perfectly dry and stored in a sealed vessel. Consequently, a general sample of cement as some advocate, could not be used as a means for standardizing sieves.

Circular No. 39 of the Bureau of Standards says that "the warp wires can be differentiated from the shoot wires by the greater bending of the former and are indicated on each sieve tested by the stamping of the Bureau of Standards number and seal on the rim at one end of the diameter extending in the direction of the warp wires." Three of the five sieves that I have used conform to this description; one has the seal stamp near the diagonal point slightly favoring the warp; and one has the seal stamp nearer the direction of the shoot wires, showing that this description cannot be relied upon entirely for this information. Further, inspection with a microscope shows the warp wires bent up and down much more than the shoot wires. The shoot wires appear nearly straight. In the absence of a microscope, two trial tests can be made with the wires at right angle with the operator in each test, holding the sieve for the second test at right angle to previous position. The results will show plainly, by their difference, which are the warp, and which are the shoot wires, the former (warp) giving the higher results.

It would not require a great deal of time for any laboratory to conduct tests along this line and convince itself of the cause of the variation which has been so annoying and unexplainable.

I do not know whether or not there is yet a mechanical testing apparatus among the few that have been rigged up that make the fineness test with such satisfaction that the results could be accepted by both the manufacturer of cement, and consumer. But this looms up as the advantage of a successful mechanical apparatus for making this test—the fineness test—which is conceded by all who make it to be an endurance test for the operator, as well as a test for the fineness of cement. With a correctly adjusted apparatus it should be possible now to make any number of tests with a sieve using from one sample lot of cement, that will obtain in every case exactly the same results.

FIELD AND OFFICE

Erection Work on a Heavy Printing House

The exceptionally heavy construction of the frame of the Hill Publishing Co.'s new printing-house, the Hill Bldg., Tenth Ave. and 36th St., New York City, has not interfered with rapid progress in steel erection. The Hay Foundry & Iron Works set its first derrick in the middle of October, 1913, began placing columns about Nov. 1, and is just erecting the roof beams.

The building fronts 100 ft. on Tenth Ave. and is 175 ft. deep, 12 stories high. It is designed for a floor live-load of 300 lb. per sq.ft., and in addition is made unusually heavy and stiff against vibration from the operation of printing-presses. The character of the framing is shown by Figs. 1 and 2. In Fig. 1 are seen the deep girders and their rigid-joint connections to the columns. The columns are Bethlehem H-columns, but in the four lower stories most of them have one to three cover-plates on each flange, and some have also web-reinforcing plates (Fig. 2). The lengths of column weigh 6 to 8 tons. The girder bays are 24 to 28 ft., requiring duplex girders of 26-in. Bethlehem section. Concrete filling in the space between the girders of each pair and in corbels at the tops of the columns will add farther stiffness. The beams, 15-in., about 8 ft. on centers, carry flat-arch tile floors of 16-in. tile, a new size made specially for this building. The floor filling, fireproofing, etc., will be stone concrete (no cinder concrete used in the building). The floors will be concrete with Master Builders surfacing. No wood whatever is used in structure or trim.

The footings are on rock, 20 to 40 ft. below street level. The Crimmins Contracting Co. began excavating the site in July, using a steam-shovel for stripping and later drilling and blasting down to basement floor level.

Two guy derricks handle all steel. They are set about 80 ft. apart, each covering one-half of the ground area of the building. The east derrick has steel latticed mast and boom, the mast 80 ft. high and the boom 75 ft. long, with lifting capacity of 15 tons. The west derrick is timber, of the same size, but only 10-ton capacity. The

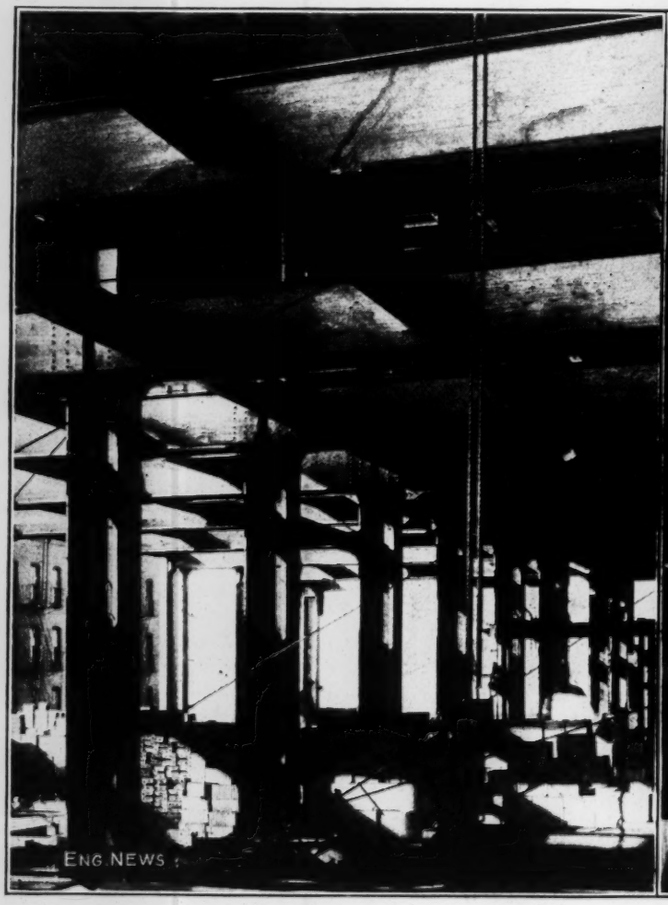


FIG. 1. DOUBLE GIRDERS AND RIGID-JOINT CONNECTIONS FOR TRANSVERSE BRACING

(To prevent the vibration found in all existing printing houses, great lateral rigidity is secured by connections of double 24-in. beams.)

FIG. 2. CROSS-SECTIONAL VIEW OF H-COLUMN AT SIXTH-FLOOR SPLICE

(This is the heaviest column in the building; heaviest Bethlehem H-section, with cover plates.)

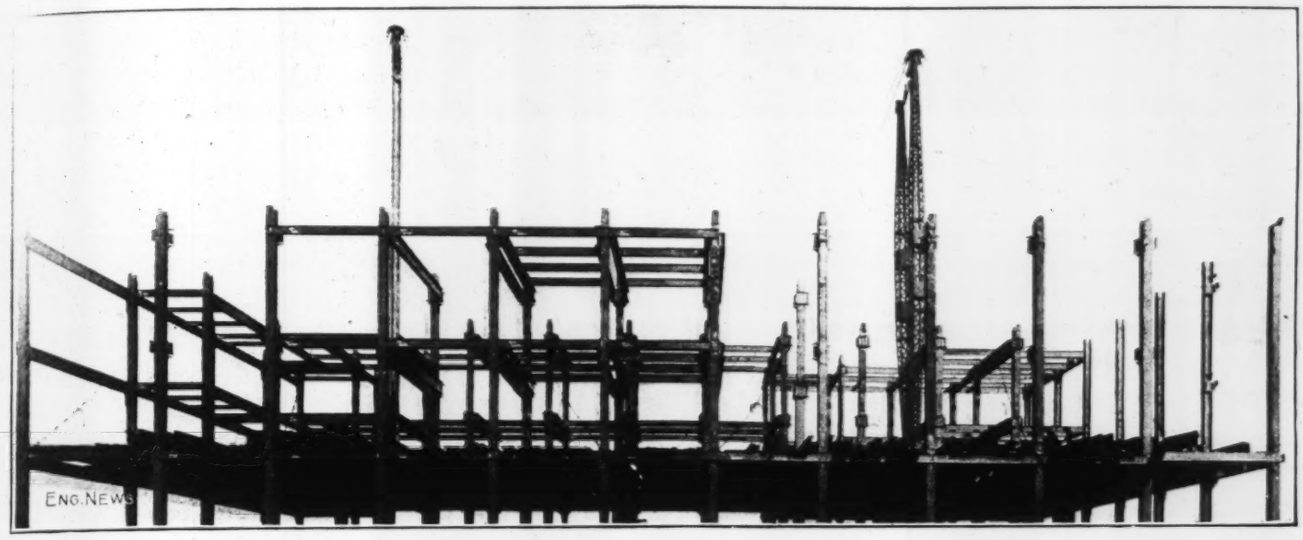


FIG. 3. ERECTING SEVENTH AND EIGHTH TIERS OF HILL BUILDING
(Dec. 6, 1913. View from roof opposite.)

eight guys of each derrick are anchored by chains to girder connections of the outer row of columns at the tier on which the derrick stands. When the boom is raised nearly to vertical position it can swing under the guys and reach the full circle. Swinging is done by hand. The two hoisting engines for the hoist line and boom falls are set on the ground floor. A force of about 100 men is used in handling and erecting the steel. The steel totals 3900 tons.

The fabricated steel is received from the Jersey City railway yards by lighter at the foot of West 36th St., and is trucked half a mile to the site. All steel is hoisted as soon as it reaches the building. Material for the west half is handled by the west derrick (wooden derrick, Figs. 3 and 4), and hoisted from the 36th St. side, while that for the east half is handled on the Tenth Ave. front by the steel derrick. It is brought in two-tier lots when the erection is ready for it, so that no extra steel has to be stored at the site awaiting erection.

The two-story lengths of column, spliced as usual just above floor-level, are generally set and splices bolted as soon as they are hoisted from the trucks. At the same time the girders and beams for the two stories above the derrick level are received, and these are piled on the completed tier until most of the columns have been set. Then the girders of the two tiers are placed successively, 6 to 8 bolts being put in each connection; then the beams are swung in and bolted. The columns and beams nearest the derrick and between derrick and point of hoisting from the street are left out until the last. When they have been set, the derricks are ready to move up.

The usual procedure of raising the derricks follows. The boom is unstepped, hoisted by a line from the mast top, set on a temporary base at the new level, and properly guyed; then a line from the boom is hitched to the middle of the mast and lifts it with its foot-block to the upper tier, where it is set and guyed and the boom stepped.

Tile setting goes on two or three stories behind the steel erection. After laying up the first floor, two motor-driven hod hoists were installed to raise the materials to the upper floors. A force of about 125 men on tile work manages to keep up with the progress of the steelwork.

The entire job is handled in individual contracts, under the management of the architects, Starrett & Van Vleck. The building will be ready for occupancy before May, 1914.

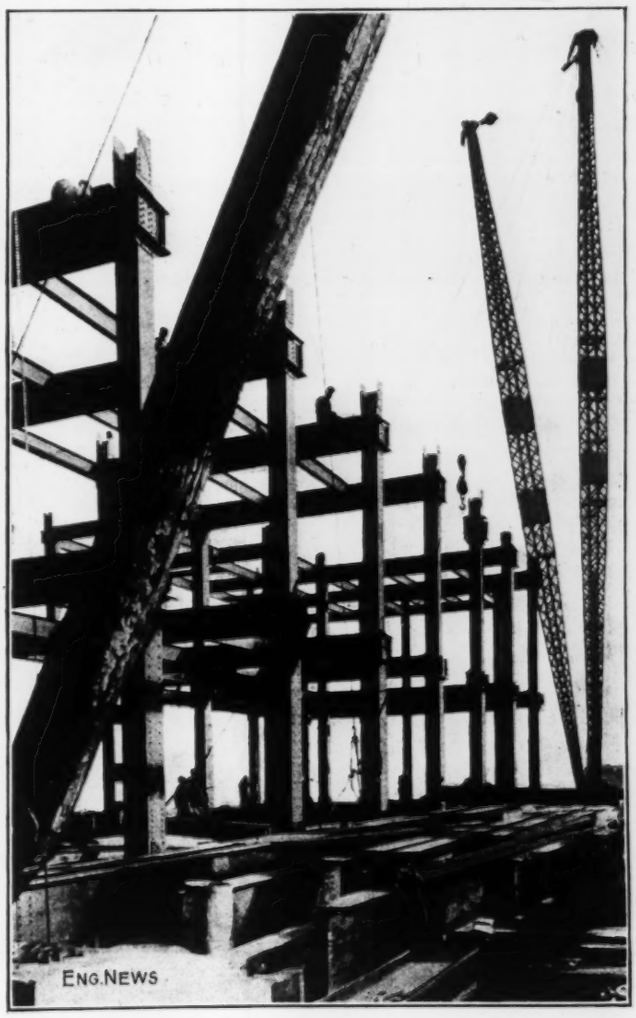


FIG. 4. TWO 80-FT. DERRICKS SET TO COVER WHOLE AREA OF BUILDING
(Steel derrick 15-ton capacity, timber derrick 10-ton capacity.)

Notes on the Construction of a Large Earth Dam in Somerset, Vt.

In connection with a chain of power developments on the Deerfield River in Massachusetts and Vermont, the New England Power Co. has just completed a storage reservoir in the upper reaches of a branch of this river, in order to increase the stream flow during periods when the rest of the drainage area does not supply the desired amount of water. This reservoir is notable chiefly because of its dam—an earth fill without masonry core wall, 2080 ft. long on the crest, and of a maximum height of 106 ft. as finished without final settlement. The work was started in September, 1911, coincident with work on the other projects in the Deerfield Valley, and was completed on the first of December of this year, except for a little work in the spillway channel. The construction of this large earth fill shows many features of interest.

The dam is located at what was Peck's Mill, in the town of Somerset, Vt., about 20 miles north of the Massachusetts state line. At the site, converging hills [illegible] in a small valley with steep side slopes, the land [illegible] wooded but recently cut over and of no agricultural [illegible]

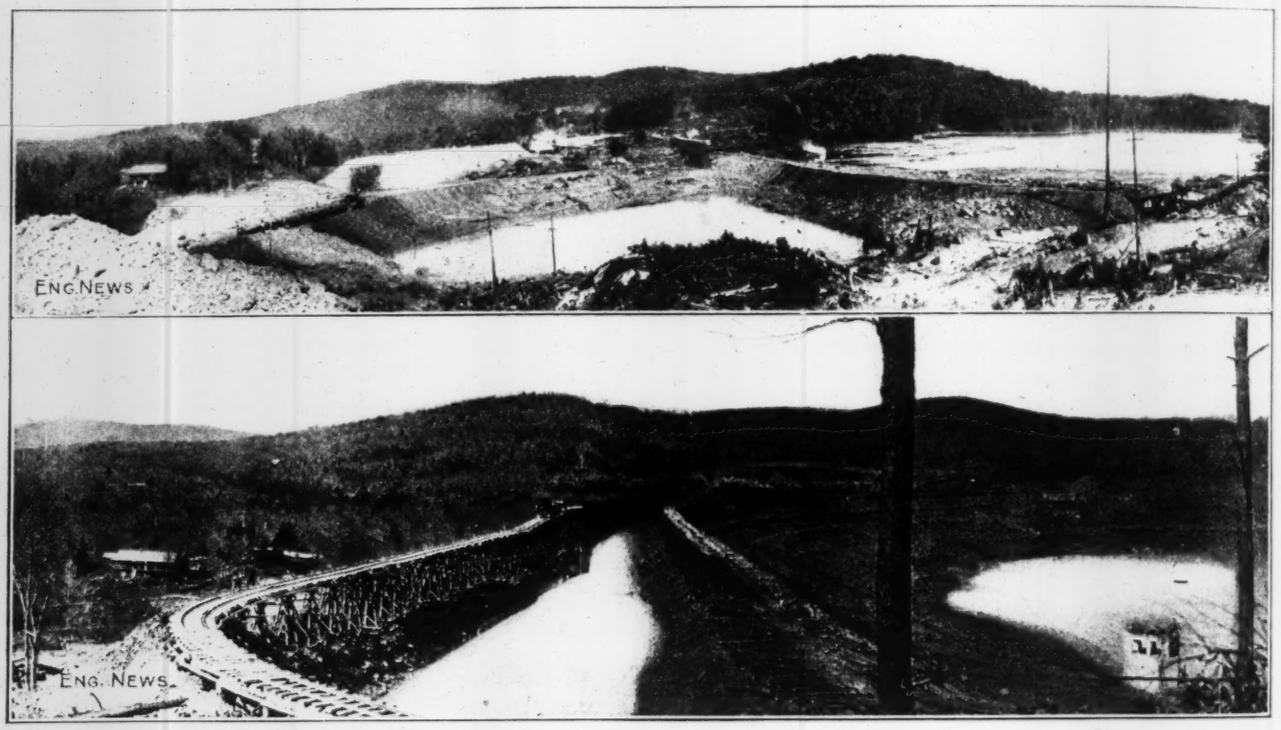


FIG. 1. SOMERSET DAM UNDER CONSTRUCTION
(Looking west from east end on July 26, 1912, and Oct. 17, 1913.)

A closely related subsidiary concern of the power company—the Power Construction Co.—was organized to handle the design and construction of all these projects. It carried through the construction of this dam with its own forces, while much of the construction on the river below was sublet. The president of the Power Construction Co. directed the administration, purchasing, etc.; under him was the engineering force, the superintendent of construction, and the accounting department. That the interests of the power company might never be subordinate to those of the construction company, the engineers were charged with the responsibility for the satisfactory design and execution of the work and given the power to report back past the construction company to the directors of the power company, about any engineering features of the work.

SUPPLY AND CAMP HANDLING

On account of the sparse and scattered population, there were no large stores of supplies close by, making it necessary to ship in from a distance the comparatively large amounts of food, etc., required for a force of up to 500 men. However, the Boston & Maine R.R. connects at Hoosac Tunnel with a branch line, the Hoosac Tunnel and Wilmington R.R., and a narrow-gage lumber road runs farther up the Deerfield River from near Wilming-ton to the immediate site of the dam. With these facilities service was fair, considering the necessarily limited equipment of such branch lines and the heavy normal traffic at times. Furthermore, in July, 1913, the road to Wilmington was converted from narrow-gage to standard. The dinky locomotives and construction cars were sent in most of the way on their trucks; the steam shovels were fitted with convertible trucks, so that they could be shipped over both broad and narrow-gage roads without loading.

While this dam was built in country where the chief industry is lumbering, most of the cut was hard wood, so that much of the lumber for the work had to be shipped in from other localities. The rough timbers for trestles and ties, however, were cut on the spot.

There were two construction camps, one (the larger) for foreign labor and the other for Americans (more skilled mechanics). All these houses were built of rough boards, with tar-paper covering and building-paper lining. These camps were located on the sloping hillside below the dam. Closer to the dam were two houses, one

for the president and the superintendent, and the other for the engineers, this containing an office and living rooms.

A gravity supply of water was secured by damming a small brook which runs into this branch of the Deerfield River near the camp. On account of the presence of men and horses on the watershed, however, the whole camp was advised to boil the water. Also, the supply pipes were connected through proper valves to construction pumps, noted later, so that in case of fire a large supply at higher pressure could be secured. However, the buildings were small and the camps spread out so that there could be no danger of rapid spread of flames. Only a couple of isolated buildings were burned during all the work. The camp had its own sewerage system, and electric lights were furnished with current from a generator in the camp's machine shop. The company maintained a camp hospital and kept a doctor.

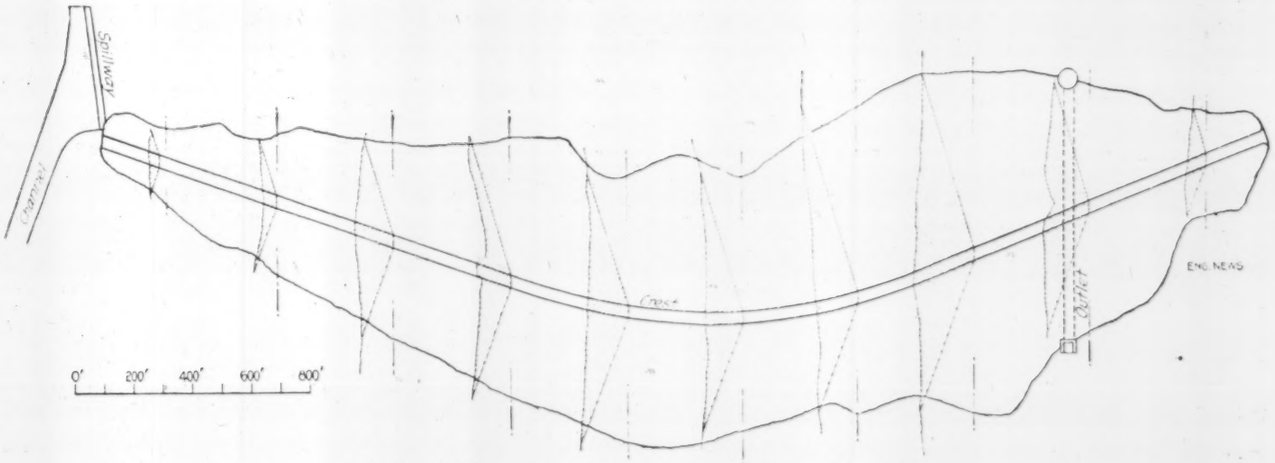


FIG. 2. PLAN AND SECTIONS OF SOMERSET DAM

(Sections at 200-ft. intervals on east-west line. Outlet conduit and spillway channel in approximate locations.)

PRELIMINARY WORK

Only preliminary work was done in the fall of 1911. During the winter, the principal work was to cut a trench through rock on the east side of the dam site and to complete therein the outlet conduit. The forms for the conduit were of heavy wood made in panels so that they could be used in sections. In the spring of 1912, the old timber-crib dam and sawmill at the site were destroyed and the whole site of the dam above water was carefully stripped to impervious earth or rock. A large amount of refuse had to be removed from what had been the old mill pond. This stripping was largely done by hand labor and teams, scrapers, etc.

BORROW PIT—While this work was going on, two 2½-yd. steam shovels were opening up a cut to a borrow pit on the west side of the dam. This cut was run for about a half mile on an upgrade of some 5% maximum, passing through a number of rock ledges. The location of the pit was a gently rising slope which by test pits had been found to contain satisfactory material, a glacial drift with some 30% of clayey material and running from very fine material to sand, gravel and boulders, well graded. The pit was opened up on two levels and, as the height of the dam increased, the shovels worked farther up the hillside, the result being that the downgrade from the pit to the dam was gradually decreased, though not much. At first there were seven dinky locomotives (19-ton) and 70 four-yd. narrow-gage cars. For the last season's work, however, three more locomotives were put on and 30 more cars, making in all ten locomotives and a hundred cars. During this last season too, a borrow pit was opened up on the east side of the dam and a third 2½-yd. steam shovel put in, reducing the length of haul for a considerable part of the fill.

MAKING THE FILL

First, in starting the fill, a couple of 20- to 30-ft. trestles were run out some 50 ft. inside the upstream and downstream toe lines of the dam, and material from the pit was dumped off these, working out from both ends of the dam. These four toe fills were thus pushed out until the water was reached when the gap in the upper dike was filled in. When this was done, the water rose until the entire flow was through the conduit. The pool between the two dikes could then be drained through the gap in the lower dike and the remaining work of stripping the site completed.

When the work was in this stage, a pumping plant was built just above the dam, taking water from the reser-

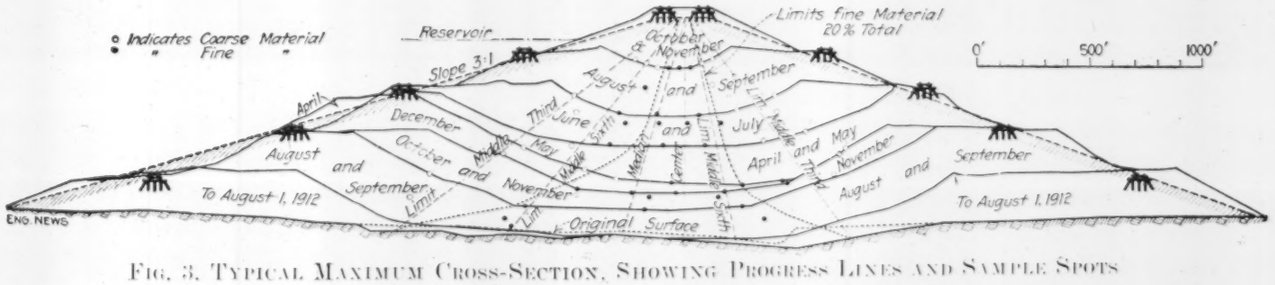


FIG. 3. TYPICAL MAXIMUM CROSS-SECTION, SHOWING PROGRESS LINES AND SAMPLE SPOTS

voir for 6-in. supply lines laid along both trestles. There were in this plant three 60-hp. locomotive-type boilers, two compound duplex pumps rated for 750 gal. per min. at 200-lb. pressure, and one smaller pump as a spare unit. Only 150 lb. pressure was held on the pipe lines, however. The lines were fitted every 50 ft. with T-fittings and valves for connecting on lengths of 3-in. rubber sluicing hose fitted with 1½-in. taper nozzles mounted on portable wood stands as monitors.

The material dumped from the trestles was undercut with streams from these nozzles and washed down into position. Obviously a pool was created between the two dikes and the finer material settled in the center. At times alum was used in the sluicing water to increase the precipitation of clayey material, but this was finally abandoned as unnecessary. An 18-in. concrete pipe was carried up from a hole in the outlet conduit; through this the excess water was drained and the depth in the pool regulated, being allowed to vary between 10 and 20 ft. The outside faces of the two dikes were filled with coarser material and boulders from the pits and this, on being washed down into place, gave a satisfactory rock face without riprapping.

When the washed fill reached the level of the trestles, the tracks were shifted inward as may be seen from the progress lines in Fig. 3. Five heights of trestles were run in during the work on the dam; the old timbers were not pulled.

Testing the Dam Body

Samples were taken at each five feet along the length of the dam to see if sufficient fine material was being deposited to build up a satisfactory impervious core. In sounding the center pool the bottom at each stage was always found quite hard, and examination of the accumulated samples shows that the fine material has considerable bonding property. The two years occupied in construction has given opportunity for much of the expected settlement, which is small with such a washed fill, but the dam has been carried to an excess height of about 4 ft. to care for any gradual settlement and any natural change of future years.

During the past season the concrete spillway has been completed and drilling for the spillway channel started through rock on the west side of the dam. This work will be completed during the next few weeks. The upper material was removed by steam shovel after shooting well-drill holes at grade. Remaining work has been handled by derricks with steam drills where material was not sufficiently broken up at first.

Geo. W. Bunnell, as President of the Power Construction Co., has been the active head of all the work described. A. A. Conger, as Hydraulic Engineer, has been responsible for the design and inspection: E. E. McD. Moore was the first Resident Engineer, later J. Albert Holmes held this place, and during recent months C. F. Cook, formerly Assistant Hydraulic Engineer and later Assistant to the President. The Superintendent of Construction was E. F. Gosselin. J. N. H. Cornell, as General Manager, had charge of the original plant installation and early construction.

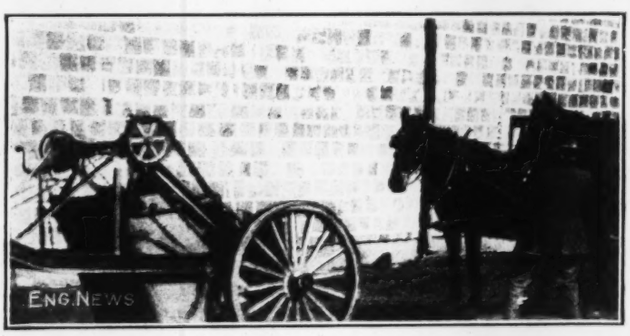
The consulting engineers were Albert S. Crane, of J. G. White & Co., New York, Charles T. Main and Frederic P. Stearns, of Boston. Baker, Ayling & Co., of Boston, have acted as bankers and fiscal agents for the New England Power Co.; Chace & Harriman, Inc., of Boston (the interests behind the Connecticut River Power Co., and the Connecticut River Transmission Co.), have been in intimate touch with the conception and management of the whole Deerfield development.

Excavating with Large Scrapers

By A. B. McDaniel*

The university of Illinois is at present (November, 1913) completing the construction of the largest school armory in the world. The building is 400x200 ft. The 13 three-hinged steel arches, which form the main frameworks of the building above the floor, rise to a height of 94 ft. The land south of the building is being graded to form a large drill ground, which will cover an area of about 18 acres, being 1000x800 ft. The soil is being removed so as to leave a two-foot terrace surrounding the field, which will be given a slight crown and have a 7-ft. fall in the diagonal length of the field.

The contract for the excavation and grading of the field was let to Purtsman, Wetzel & Wetzel, of Danville, Ill., and comprises the moving of 29,000 cu.yd. of earth for 30c. per cu.yd.



A Two-Horse Maney Scraper, Showing the Pan Elevated after Dumping

Fourteen Maney four-wheel scrapers are being used and two traction engines for loading. This scraper is made by the Baker Mfg. Co., of Springfield, Ill., in two sizes; a two-horse, holding 1 cu.yd. and a three- or four-horse, holding 1½ cu.yd., the former outfit being used on this job.

The pan of this scraper is swung on chains between steel frames, carried on two trucks. The pan is hung so that only the front or cutting edge touches the ground. The front wheels are small and underhung so that short, sharp turns may be made. The pan is operated by four levers, all within easy reach of the operator, who is seated just above and behind the rear trucks, on the right side of the machine. The figure shows this scraper, with the pan elevated after dumping.

The scraper is usually drawn by two or more horses or mules, while a traction engine furnishes the extra power for loading. A wire cable attached to the engine has a hook on the free end, which can easily be slipped into the eye on the end of a steel rod fastened to the tongue of the scraper. A man is necessary in hooking and unhooking the tractor cable to the drawbar of the scrapers and another man is required to direct the loading operations, which take from 10 to 30 seconds.

*Assistant Professor of Civil Engineering, University of Illinois, Urbana, Ill.

The pan, when filled, is elevated automatically by a chain-and-sprocket. The machine is then hauled to the dump while the pan is elevated to the proper height, and an automatic trip throws the axle-clutch out of gear, stopping the winding and preventing the machine from becoming spool-bound. The load is then dumped through a gate in the rear of the pan.

The soil excavated is about a foot of loam underlaid with yellow clay. The average load hauled was ¾ cu. yd., making a total weight (with scraper) of two tons—a heavy load for two animals unless the soil is fairly firm and hard. In this case the soil readily packed and except for short periods after rains, when soft spots occurred, the hauls were over nearly level and hard tracks. The writer would advise the use of three-animal teams for 1-yd. scrapers when the soil is soft or wet and the topography rough.

The scrapers were generally divided into two unequal groups of 10 and 4 and a traction engine allotted to each group, as a loading auxiliary. Experience would indicate that from 8 to 10 scrapers can keep an engine busy, while with 4 the engine was actually working about 40% of the time. The engine used with the larger group of scrapers is a gasoline traction engine of 25-55 hp., operated by one man, as regards stopping and starting. A scraper in a 30-ft. haul was generally filled in 15 seconds.

In order to serve an almost continual line of scrapers, it was necessary to keep the tractor moving back and forth rapidly. The engine was allowed an occasional respite on account of delay in handling the scrapers and this time was profitably employed in oiling the machinery, adjusting movable parts, etc.

The other tractor was a steam-power machine of 20-45 hp., with one operator serving as both engineer and fireman. This machine could not be controlled as efficiently and probably could not handle as large a number of scrapers as the gasoline tractor.

The length of haul varied from 400 to 800 ft. with a round trip of from 1000 to 1800 ft. The average time for a scraper to load, haul 500 ft. and dump, was 4 min. and the round trip of 1200 ft. was made in about 10 min., allowing for occasional delays.

The following analysis of the cost of operation is made upon the observation of a day's work for the group comprising 10 scrapers and the gasoline-power traction engine. The average haul was 500 ft. and the round trip, 1200 ft. The average amount of earth excavated and moved per scraper per day was 50 cu.yd., making a total volume of 500 cu.yd. for the 10 scrapers.

LABOR

2 sub-foremen* @ $3.00	$6.00
1 cable-man @ 2.00	2.00
14 teams and drivers @ 45c. per hr.	63.00
Total cost of labor per 10-hr. day	71.00
Cost of labor per cu.yd., excavated	$\frac{\$71.00}{500} = \$0.142$

LOADING AUXILIARIES

1 traction engine and operator	$14.00
Cost per cu.yd. excavated	$\frac{\$14.00}{500} = \$0.028$

*One man to direct the loading and one to direct the dumping. The traction engines were rented by the general contractor. The writer secured the following data from the operators.

GASOLINE TRACTOR

35 gal. of gasoline per day @ 15 cents	$5.25
1½ gal. lubricating per day oil @ 37 cents	0.55

STEAM TRACTOR

½ ton of coal per day	$2.00
Lubricating oil, per day	0.50

GENERAL AND OVERHEAD EXPENSES

Supervision and general office expenses	$5.00
Interest on investment (8% of $4000)	0.87
Depreciation per day based on 10 year life	1.33
Repairs estimated	1.00
Total general and overhead expenses	$8.20
Amount of general expenses, per cu.yd. excavated	$0.0164
Total cost of work, per day	93.20
Total cost of work, per cu.yd. excavated	0.1864

Replacing a Timber Howe Truss with a Long-Span Plate-Girder

A bridge replacement carried out in an unusual manner was done on the Duluth, South Shore and Atlantic Ry. main line at Bad River crossing, near Shilo, Wis., on Nov. 16, 1913. A 150-ft. Howe-truss span forming part of a timber trestle viaduct was replaced by a 121-ft. plate-girder span. This span is the river span of a plate-girder viaduct which has been erected in place of the trestle; the river span is 121 ft. long between centers of bearings, 122½ ft. long over all, and weighs 108 tons.

The new viaduct is shown in outline elevation by Fig. 1 herewith. It is 955 ft. long and consists of 30-ft. tower spans and 64-ft. intermediate spans, except for the 121-ft. river span. All spans are deck. The towers and bents are steel on reinforced-concrete footings on piles. Base of rail is 90 ft. above bed of river and 73 ft. above high water.

Erection of the new viaduct, under maintained traffic, involved as its most difficult and interesting item the erection of the river span. It was complicated by the fact that the new steel bents for supporting the span fouled the old trusses, and the chords of the latter had to be cut and reinforced to give room for setting the bents.

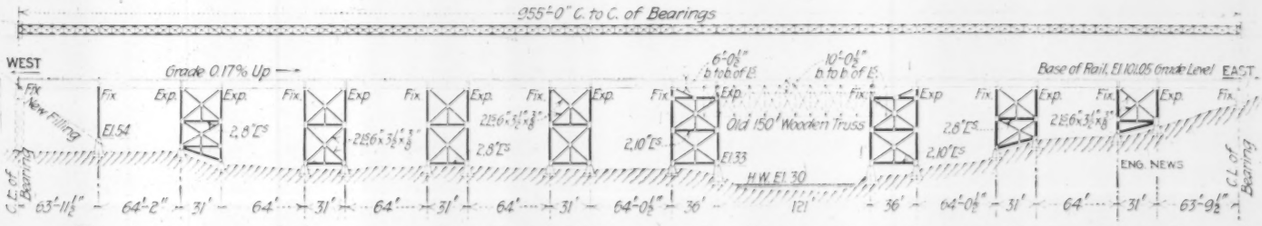


FIG. 1. OUTLINE ELEVATION OF BAD RIVER VIADUCT, NEAR SHILO, WIS.; DULUTH, SOUTH SHORE & ATLANTIC RY. CO.

The span was riveted together complete on two flat cars, and in this state was hauled onto the Howe span, as shown by the view, Fig. 2. A derrick car then handled one end of the span and a gallows-frame hoist handled the other end. The span was lifted off the cars, and the cars were then run out at the gallows-frame end. Now the deck of the Howe-truss span was removed, and dropped piece by piece into the river, where the wood was caught by a boom and fished out and piled on the bank. The floor being out of the way, the new girder span was lowered into position on its bents between the

old trusses. Removal of the old work followed at leisure.

The span was hauled out onto the bridge at 7:30 a.m., and was finally connected to its bearings at 2:30 p.m., the same day. The whole work was carried out without the slightest mishap. It was done by the erecting department of the American Bridge Co., under the direct supervision of Erecting Engineer A. C. Beckman, and Foreman I. M. Duncan.

The reinforcing of the old structure was done by the railway company's general foreman, George Mercer.

The wood trestles and trusses of the Duluth, South Shore and Atlantic Ry. and the Mineral Range Ry. are being replaced as rapidly as possible by steel bridges. This is part of a general program for increased efficiency inaugurated by General Manager W. W. Walker in 1912. The bridges are being designed by the engineering department: E. R. Lewis, assistant to general manager in charge of engineering, and J. E. Bebb, office engineer. The new structures are designed for Coopers E50 loading.

In the case of the Bad River Viaduct, the long girder span was used in preference to a truss span on account of the wide difference in cost of erection of the two types of bridge under the conditions existing here. Pile foundations and heavy reinforcement of the concrete footings were necessitated by the treacherous red-clay bottom.

The Bad River viaduct contains 773 tons of steel. The material was received at the site in less than 3½ months from the time the railway company placed the order with the bridge company's Duluth contracting manager, W. G. Zimmermann.

FIG. 2. LIFTING THE 108-TON RIVER SPAN OFF TWO FLAT-CARS, READY TO LOWER TO ITS SEAT AFTER TEARING OUT OLD FLOOR

(To erect steel supporting bents of this span the bottom chords of the Howe truss had to be cut and reinforced.)

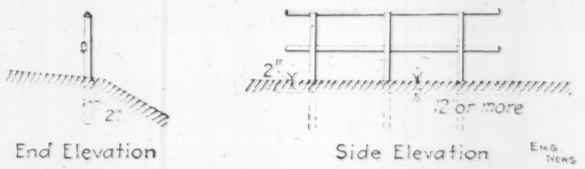
❖

A Settlement of Flood Loss, between the city of Black River Falls, Wis., and individual flood sufferers against the La Crosse Water Power Co., was compromised according to press dispatches of Nov. 14. Claims against the company aggregating $600,000 were filed. A majority of the individual claimants and the city have decided to accept the company's offer of $50,000 as settlement.

Railing with Subsurface Curb for Shoulders of Road Embankments

BY ROLAND WATTS*

One of the worst problems we have to contend with in the maintenance of completed roads in the hilly and sandy parts of this country is the trouble caused by washouts. I have tried in a number of ways to prevent these washouts. I have had the sand shoulders kept dragged and in good shape, with sufficient slope for quick getaway of the storm water on heavy fills. But just as soon as two teams pass on the road, one of them, at least, must get out on the shoulder (on ordinary width of macadam) and leave a wheel rut, and in the first rain this rut soon develops into a dangerous gully. Where the water leaves the fill at a low point in the grade, it takes a section of the shoulder away with it, and if it happens to be a fill of 4 ft. or over, where we have guard rail, it sometimes takes the guard rail with it.



SHOULDER CURB FOR SHOULDERS OF ROADS ON FILL

I have tried sodding these places subject to washouts, but find this pretty expensive, and often useless, as we may have a heavy rain just after the sod is put on, and there is just that much labor wasted.

But I finally hit upon a plan where we have guard rails on dangerous embankments, which has been fairly successful in protecting both the guard rail and the shoulders from heavy rains. Following is a sketch of the idea:

A 2x12-in. plank is set on the outside of the guard rail, about 2 in. below the shoulder line. On exceptionally bad places, where we have to take care of a great volume of storm water on a heavy fill between two steep grades, I use two and sometimes three planks instead of one. Placing these planks on the outside instead of the inside of the guard rail prevents the posts from becoming undermined.

❖

Pneumatic Riveting—In erecting the 21-story steel frame of the Commercial and Continental Bank Bldg., Chicago, 18 Boyer riveting hammers were run from one large air compressor. The compressor was motor-driven, and had automatic shut-off valves. It was built for the work by the National Brake & Electric Co., Milwaukee. The erectors, Bergendahl-Bass Engineering & Construction Co., say that the plant proved economical and reliable.

*Highway Commissioner, Florence County; Florence, Wis.

Economies on Small Rock-Drilling Jobs

The unit costs of drilling ledge and boulders in trenches for sewers, water pipes, etc., and other construction work in city streets have always been high, because it is seldom economical to install a steam-power plant and piping for such small jobs, and drilling by hand in a large city where wages for labor are high is necessarily expensive. The advent of a portable air compressor (operated by electricity or gasoline engine) not too heavy to be moved easily from street to street has seemed to solve the problem of accomplishing this class of work economically.

Based on hand-drilling costs, a standard rate of $4 per cu.yd. has been allowed for rock removed within trench limits on water-main installation work in Boston, Mass. The amount allowed in solid rock per running foot in ordinary trenches for water pipe is 15 cu.ft. Actual costs of this Boston city work, sent us by Frederick I. Winslow, an engineer in the Sewer and Water Division of the Public Works Department, are as follows:

With a hand-drill the number of feet drilled in a working day of 8 hr. varies from 8 to 12 ft., the cost per day of the drill gang is $7, the cost per lin.ft. drilled about 87c., and the cost per cu.yd. of rock excavation about $3.50. A steam-operated drill is capable of 50 to 70 ft. per 8-hr. day, the cost of operation $12 per day, the cost per lin.ft. about 24c., and the cost per cu.yd. of rock excavation about 96c. A compressed-air drill is able to drill from 80 to 120 ft. per day, and the cost of operation, including an allowance for depreciation, repairs, moving, etc., is $16 per day, the cost per lin.ft. about 20c., and the cost per cu.yd. of rock excavation about 80c. The difference in favor of the compressed-air drill is greater than the figures show, according to Mr. Winslow, on account of the greater ease of manipulation, and the fact that the compressor can be operated by unskilled labor.

The above costs for steam and compressed-air drills are based on but one drill operated from the power plant, although, of course, either type of plant is capable of operating other drills; with the small portable air compressor used two drills may easily be operated simultaneously.

Protecting Plate-Glass Windows against Blasting Operations

The blasting operations along Lexington Ave., New York City, during the construction of the new subway, resulted in the shattering or cracking of many plate-glass show windows on the contract section of the Bradley Contracting Co. As a clause in the contract makes the contractor liable for any damage to adjacent properties, he felt constrained to devise some means for preventing the breaking of expensive windows along the route.

Several schemes were tried, and the one finally adopted, June 1, is very simple, cheap and easily applied; it is also effective. Two wooden crosses, each with a projecting pin at the intersection of the arms, are placed opposite each other, against the pane, one on either side, with rubber packing between the blocks and the glass. The number of such sets which may be placed on one window depends upon the dimensions of the latter. No. 10 annealed steel wires (both inside and outside of the window) are then stretched across the pins which project from the wooden blocks, from screw-eyes in the lower window frame to similar connections in the upper.

On the average store window four sets of blocks are placed. The two vertical sets are connected inside and outside by wires. The reinforcement, therefore, takes the form of two simple trusses against the outside of the window and two similar ones placed opposite on the inside.

The field engineer of the contractor informs us that but little breakage of windows occurred while the excavation work was carried on in the open cut between 81th and 91st Sts., but that in the tunneling work where heavier charges are fired, it was not uncommon to have as many as four store windows break in a day.

One of the schemes tried and found unsuccessful was to place wooden strips vertically and horizontally across the glass. This construction was found to be too rigid, not allowing sufficient play for the glass in its vibration following a blast. Since the adoption of the wire-truss reinforcement method, according to the engineer, no plate-glass windows thus protected have been broken. Only one truss-protected window is known to have broken, and that was of ordinary window-glass.

Collection and Use of Construction Cost Data

It is notorious that the average engineer makes an unsuccessful contractor; also that engineers' estimates often fall far short of actual costs. As often emphasized* in ENGINEERING NEWS, published cost data must be used with extreme caution—never unqualifiedly by the inexperienced engineer; and such published cost data are chiefly useful merely for purposes of comparison with one's own work. All the books of cost data ever published cannot supply the place of accurate data compiled from one's own experience, under conditions which are known and fully understood, and almost certain to be repeated.

That is why many experienced engineers and contractors give such advice as did F. D. Hughes, of Hughes & Hammond, general agents at Kansas City, Mo., of the Illinois Steel Bridge Co., in a paper before the Kansas Engineering Society.† Mr. Hughes said: "Books of cost data can be had covering every class of construction from a concrete fence post to a Keokuk dam, but their reliability and accuracy should be taken with just as much confidence as one would take the patent medicine of the old almanac variety as a cure-all for the ills of the human body." In the paper referred to Mr. Hughes described the cost-accounting system developed by his firm, from which we have made a brief abstract.

The system was the outgrowth of a costly experience when the firm first embarked in the new field of reinforced-concrete-bridge construction, after several years' experience building steel bridges. This first venture was a bridge in a bad location and of an expensive design, yet the very common mistake was made in assuming that a design which was low in cubical contents must of neces-

*See editorial in "Engineering News," Dec. 23, 1909, p. 708.

†Published in the "Transactions" of the Kansas Engineering Society for 1913, p. 105.

sity be low in cost. It was learned by sad experience that all is not profit in concrete work which is above the cost of the material, and it was also learned that the cubic yard as an arbitrary unit of estimating cost was most unreliable.

As is usual, the estimating department could not be brought to acknowledge that the estimated cost was too low, and it was concluded, of course, that the field foreman was too expensive, if not actually dishonest. A cost-accounting system which was then developed, while not perfect, gave at a glance the rate of progress of the work and the relations of estimated and actual cost as the work progressed. This system of cost-keeping originally conceived with the intention of convicting the field foreman of dishonesty ended in convincing the estimating department of its incompetency.

To fully understand the need of each item on the accompanying estimate forms it is necessary to take up chronologically the various stages of development. Form 1 will be noted the meager detail of the field c consisting only of the two items in each subdivision hauling and erecting. This system of estimating, as M Hughes said, was little better than a mere lump-su guess of the cost, and the reason it did not break m contractors was because most of the work was of a v uniform design.

Concrete work was then almost universally figured the cubic yard, and generally not more than three or fo items of expense were considered in analyzing the co per cu.yd. Form 2 was the first devised for a more com plete analysis of concrete-bridge costs. It was soon re lized that the more subdivisions in the estimate the nearer the estimate approached the actual cost, so the change was made to Form 3, which is the one now used by Hughes & Hammond.

A copy of each estimate is pasted on the opposite side of the folder containing the field reports (which are of the same general form) thus making it possible to compare at a glance the actual field cost as the work progresses with the previous estimated cost for which the work is under contract. This immediately shows where the estimated and actual costs are disagreeing or are going to disagree, and it is the duty of the erecting department to explain and to remedy the defects if possible; or valuable knowledge is gained by the estimating department to be taken account of in making future estimates.

One great advantage Mr. Hughes claims for a carefully analyzed estimate, based on data of personal experience, is that the firm is more likely to get the desirable contracts, losing the ones which from personal experience have been found to have a large percentage of expensive construction units. Mr. Hughes said:

> We have always found that it is more preferable to have a small number of contracts, all profitable, than a large number with a considerable percentage showing loss; the most-to-be-feared competitor is the one who knows the least, not the one who is unfamiliar with methods of construction, for the best superintendents are usually the poorest estimators, but the one least informed on the character and cost of the

FORM 1. ORIGINALLY USED FOR STEEL BRIDGE ESTIMATES

ESTIMATE. Inq. Cont. Drawing No. Letting at 191
Loct. Purch. Shp. Pt.
Span Sub. Appr.
Span C. to C. Depth C. to C. Roadway clear. Details
Floor Joist Whl. Gd. Rail

SUPERSTRUCTURE		Cont. Price	
Metal	@	Cost	
"	@		
"	@	Est. Profit or Loss	
Freight	@		
Lbr.	@		
"	@		
Haul	@		
Er. P. & N.	@		
SUBSTRUCTURE			
Metal	@		
"	@		
Freight	@		
Lbr.	@		
Piles Driven	@		
Con. or Mas.	@		
Haul	@		
Erection	@		
APPROACH			
Metal	@		
"	@		
Freight	@		
Lbr.	@		
"	@		
Piles Driven	@		
Haul	@		
Er. P. & N.	@		

FORM 2. FOR CONCRETE BRIDGE ESTIMATE

ILLINOIS STEEL BRIDGE COMPANY

Hughes & Hammond, General Agents
Kansas City, Missouri.

ESTIMATE. Inq. No. Cont. No.
Letting at 19
Location Purchaser
Stream Local Crossing
Ship
Haul Direction
No. Spans Substr. Appro.
Span CC. Depth CC. Rdy Clear. Type
Floor Joist Wh. Grd. Rail
Specification Est. By Sold By

Metal	@	Cont. Price	
"	@	Est. Cost	
"	@	Est. Profit or Loss	
"	@	Remarks:	
"	@		
Freight	@		
Lumber	@		
"	@		
"	@	Est. of Concrete per Cu. Yd.	
Concrete	@	: : Mixture	
"	@		
"	@		
Piling	@	Price Haul	
"	@	Cement + = × =	
"	@	Sand + = × =	
Haul, Steel	@	Stone + = × =	
" L. & P.	@	Forms Material =	
"	@	" Placing =	
Falsework	@	Mix. and Place =	
Erect.	@		
"	@		
"	@		
Painting	@		
Plant	@		
Gen. Expense	@		
Bond and Insurance	@		
Total			

FORM 3. FOR CONCRETE BRIDGE ESTIMATE

ILLINOIS STEEL BRIDGE COMPANY

Hughes & Hammond, General Agents

Kansas City, Missouri.

ESTIMATE Inq. No. Letting at Cont. No.
Purchaser Location
Stream Local crossing
Shipping Point
Haul Direction
No. Spans Substr. Approach
Span CC. Depth CC. Rdy Clear. Type
Floor Joist Wh. Grd Rail
Remarks
Specification Est. By Sold By

Office Items		Field Items	
Steel	@	General Expense	@
"	@	Plant	@
"	@	Hauling Steel	@
"	@	" Lumber	@
"	@	" Piling	@
"	@	" Cement	@
Freight	@	" Sand	@
Lumber	@	" Stone	@
"	@	Cofferdam Material	@
Piling	@	" Sinking	@
"	@	Form Material	@
Cement	@	Frame, Place and Wreck	@
Sand	@	Pit Excavation	@
Stone	@	Erect Tubes	@
Hardware	@	" Bents	@
Paint	@	Drive Wood Piles	@
Bond	@	" Steel "	@
Insurance	@	Quarry Stone	@
Plant and Tool Rental	@	Cut and Lay Stone	@
	@	Mix and Place Concrete	@
	@	Falsework Poles	@
	@	" Lumber	@
Total		" Frame, Place and Wreck	@
—Office Items		Raise Steel Super.	@
—Field Items		Rivet " "	@
Summary —Total Est. Cost		Frame and Place Lumber	@
—Est. Loss or Profit		Painting	@
—Cont. Price or Bid			Total

EXAMPLES OF TABULATED ACTUAL UNIT COSTS OF TYPICAL BRIDGES

Field	Steel span 140 ft., tubular foundation, interburban railway, 70 tons			Steel span 144 ft., tubular foundation, highway, conc. floor, 55 tons			40 ft. concrete, girder type, 14 ft. rdy., 156 cu.yd.			40 ft. concrete, arch type, 18 ft. rdy., 156 cu.yd.			40 ft. concrete, arch type, 40 ft. rdy., 520 cu.yd.		
	Est.	Actual	Cost per ton	Est.	Actual	Cost per ton	Est.	Actual	Cost per yard	Est.	Actual	Cost per yard	Est.	Actual	Cost per yard
Supt. and Gen'l	$286.00	$330.06	$4.75	$225.00	$496.14	$7.20	$320.00	$260.68	$1.67	$251.00	$247.73	$1.59	$700.00	$798.67	$1.87
Plant	137.00	249.52	3.82	135.00	130.60	2.30	100.00	50.25	0.33	135.00	110.50	0.91	350.00	539.96	1.04
Hauling steel	56.00	41.00	0.58	55.00	88.77	1.28	7.00	15.50	0.10	3.00	.....	.....	16.00	17.00	
Hauling lumber	.....	.....	.....	.....	.....	.....	14.00	32.00	0.21	30.00	31.48	.....	44.00	52.06	
Hauling piling	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.90
Hauling cement	25.00	17.05	0.24	29.00	55.55	.....	20.00	20.25	1.63	36.00	33.20	1.30	140.00	203.67	
Hauling sand	26.00	28.87	0.41	70.00	72.91	.....	77.00	26.12	0.16	52.00	.....	.....	500.00	472.80	
Hauling stone	Gravel	.....	.....	99.00	99.42	.....	156.00	171.31	1.05	115.00	137.72	.....	225.00	248.85	
Cofferdam, mat	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cofferdam, sinking	.....	.....	.....	.....	.....	.....	.....	25.39	0.16	.....	.....	.....	.....	.....	.....
Forms, mat	.....	.....	.....	.....	.....	.....	280.00	248.00	1.58	220.00	242.71	1.55	528.00	439.00	0.85
Forms, placing	.....	.....	.....	.....	.....	.....	140.00	218.49	1.40	220.00	180.12	1.18	330.00	375.40	0.73
Excavation	40.00	152.00	2.16	94.00	151.38	2.76	75.00	106.26	0.68	110.00	71.50	0.46	225.00	451.48	0.87
Erect. tubes	268.00	373.53	5.35	83.00	60.67	1.70	.....	.....	.....	.....	.....	.....	.....	.....	.....
Erect. bents	.....	.....	.....	4.00	7.60	0.14	.....	.....	.....	.....	.....	.....	.....	.....	.....
Driving wood piles	.....	.....	.....	.....	.....	.....	80.00	103.94	0.66	.....	.....	.....	300.00	151.30	0.28
Driving steel piles	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Quarry stone	.....	.....	.....	85.00	255.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cut and lay	.....	.....	.....	336.00	323.22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mix. & ple'g concrete	207.00	117.75	1.67	66.00	132.65	.....	195.00	289.45	1.83	195.00	202.80	1.30	580.00	413.97	0.80
Falsework	38.00	41.46	0.60	16.00	14.80	0.26	.....	.....	.....	.....	.....	.....	.....	.....	.....
Falsework, lbr	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Frame and place	231.00	245.95	3.55	44.00	131.50	2.40	25.00	11.14	0.08	.....	.....	.....	.....	.....	.....
Raising steel	297.00	313.68	4.50	79.00	111.02	2.00	35.00	28.11	0.18	16.00	26.00	0.17	120.00	61.05	0.12
Riveting steel	198.00	106.48	1.52	135.00	180.20	3.67	.....	.....	.....	.....	.....	.....	.....	.....	.....
Placing, lbr	55.00	56.40	0.80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Painting	36.00	37.50	0.53	15.00	41.47	0.75	.....	.....	.....	.....	.....	.....	50.00	10.40	0.02
Total	$1900.00	$2111.25	$27.56	$1579.00	$2233.07	$24.46	.....	.....	$10.20	.....	.....	$8.46	.....	.....	$8.20

work to be done. In competitive bidding we always approach the contest with more confidence if we know our competitors are all experienced and seasoned contractors in the kind of work to be awarded.

In the accompanying estimate forms the item of general expense is not to be confused with the office or general contracting expense, which is always left to be charged on the office side of the estimate, after the contract is completed. The item, general expense, as it appears on the estimate, covers the time of the foreman, time-keepers, and other incidental expenses which cannot be charged directly to the cost units of the work. These are the items generally lost sight of in making up estimates on a flat-unit basis, yet the accompanying table as a sample of actual unit costs shows that they are quite an item in the percentage of the whole cost.

Other things to bear in mind in making up estimates, especially on public work, is the fact that the law in most states now requires an 8-hr. day, which will increase 10-hr. day labor costs 15 to 20%. Specifications generally require a *bona fide* bond, and owing to many recent failures on construction work about double the rate of two years ago is now charged by surety companies. Recent state laws requiring employees' liability insurance also add considerably to increase the cost over a few years ago.

Depreciation of equipment must not be lost sight of. The firm of Hughes & Hammond makes it a practice to charge 5% per month of the invoice cost of all equipment on the job under construction. Machinery is also liable to unexpected and unforeseen breakage, causing expensive and vexatious delays; and the more machinery installed on a piece of work the greater the liability of accidents. On concrete work Hughes & Hammond estimate from 10 to 12% of the field cost for the necessary plant, while for steel work there would be a variation of from 8 to 15%.

After the complete design and the final estimate have been made, a mode of procedure to be followed in construction should be mapped out and a cost estimate placed on each step in the expected progress of the work; the more details taken into consideration, the better, even though the unit costs may seem small. After this is done all fixed charges which must be carried should be added, and an allowance made for general contracting and administrative expenses and for profit.

Organization for Track-Elevation Work

The proper organization of staff and of working forces is an important factor on all construction work, and is, perhaps, specially important on railway work which involves provision for handling traffic while the work is in progress. There is comparatively little published information as to this feature of engineering, and we are glad to give herewith an extract from a paper on track elevation* which outlines the system of organization employed, and a modified system now suggested as the results of experience.

When the preliminary negotiations were complete and instructions were given to proceed with the work, immediate steps were taken to develop the necessary organization. An office force was employed to handle the designing and estimating. The accounting was of such a nature as to require engineering experience. A division engineer was in charge of the construction force.

There were employed three general foremen, one each for track work, concrete construction and timber bridges. An assistant yardmaster was employed to handle the traffic. Telephones were installed at intervals along the line and (excepting a reduction of speed) the interference with regular trains was very slight.

The organization was not fully planned at the beginning of the work. It was in some respects an evolution, its various stages being the result of developments. Had the information on hand at the beginning of the work been sufficient to permit a proper organization, it could not have been formed at once because of the lack of men. Time was needed to secure the best assistants, and in some instances the organization was arranged to suit the men who were available, rather than wait for men having the exact experience needed.

This is one reason why in the accompanying charts showing the actual organization and that now recommended the titles used are not those recommended. It was easier at first to call a man an assistant engineer and later to use him according to his fitness than to find in each case a man properly qualified for some particular position.

There should have been a principal assistant, because in the rush of work many important matters could receive but scant attention from the engineer of grade elimination and

*"The Elimination of Grade Crossings at Cleveland, Ohio," by A. J. Himes, Engineer of Grade Elimination, New York, Chicago & St. Louis R.R., Cleveland, Ohio. Bulletin No. 160 (October, 1913) of the American Railway Engineering Association, Chicago, Ill.

the interests of the company suffered accordingly. It was originally intended that the field assistant engineer should report to the division engineer, but pressure of work and the experience of the men rendered the course pursued advisable.

The rate of pay for common labor at the beginning was $1.40 per day. In July, 1909, it was raised to $1.50 and in April, 1910, it was raised to $1.60. In July, 1912, it was again raised, the final rate being $1.70 per day. Concrete laborers were paid in general 25c. more per day than the rate for comon laborers. Other workmen received various rates according to their experience and ability.

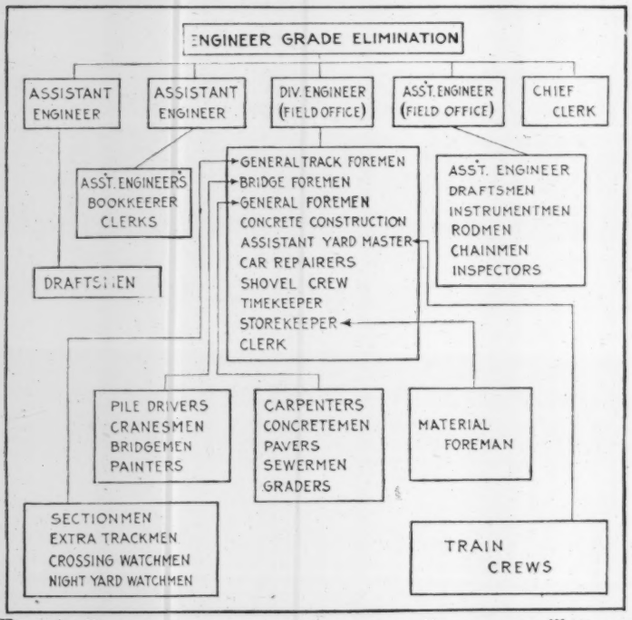


FIG. 1. ORGANIZATION OF STAFF AND FORCE FOR TRACK-ELEVATION WORK ON THE NEW YORK, CHICAGO & ST. LOUIS R.R.

The labor employed was that found commonly about the city. With a single trifling exception, near the close of the work, no labor was brought from other points. At the beginning labor was very plentiful. There had been much idleness during the preceding winter and men were eager to

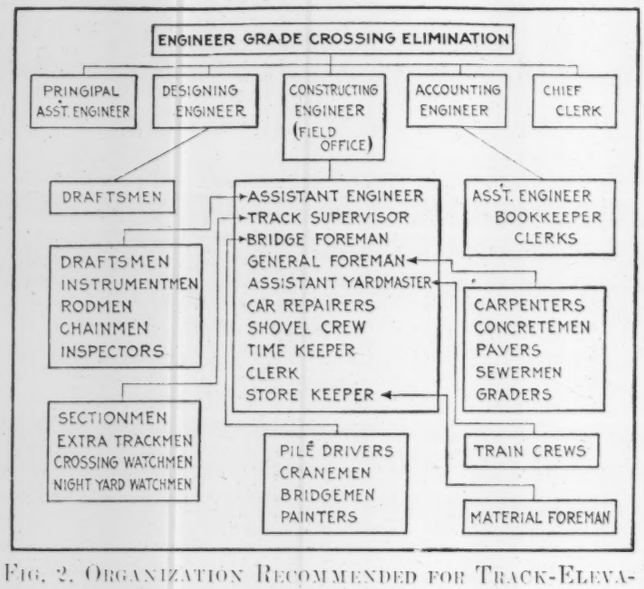


FIG. 2. ORGANIZATION RECOMMENDED FOR TRACK-ELEVATION WORK (BASED ON THE EXPERIENCE WITH THE SYSTEM SHOWN IN FIG. 1)

work. During the fall of 1912 there was an unusual amount of building in the city and the local contractors paid $2 for common labor. This condition resulted in bringing about 70 Greeks from Chicago during the latter part of the year.

The great bulk of the work was performed without regular force of inspectors. The engineering corps kept eye on the work while attending to its regular duties, and writer spent much of his time on the ground. Work performed through the agency of the city of Cleveland was spected by city employees. In East Cleveland one or inspectors employed by that city were always on the grou All foremen were made to understand fully that only fi class work was desired, and after the first few weeks th was little disposition to sacrifice quality to either speed lowness of cost.

The maximum force employed at any one time was abo 700 men. The selection of the employees was made wit great deal of care and now that the work is complete, it recorded with satisfaction that no serious blunders were m and that an unusual degree of harmony and good will p vailed throughout the work.

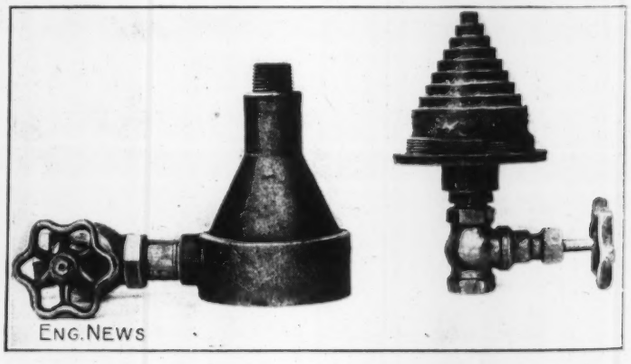
NOTES

Strain-Gage Measurements of Stresses in Arches are being made on the new drill hall of the University of Illinois, described in "Engineering News," Dec. 11, 1913. It was attempted to measure the dead-load stresses, but these were generally too small to be measured with reasonable accuracy. The measurements of stresses due to roof load are expected to be more satisfactory. Prof. H. F. Moore and G. P. Boomsliter, of the University of Illinois, are making the tests.

Cutting An Expansion Joint in A Concrete Wall—On a query in our issue of Nov. 20, 1913, as to how to cut a slot in a concrete wall to make an expansion joint not provided in the original construction, C. B. Kingsley, Toronto, says:

If the wall is accessible for the application of a shot drill working over it, taking out a suitable core on the line of the contemplated joint, I think this method would be found applicable and of low cost, if in a locality where a shot drill could be rented. A core large enough to cut the wall could be taken leaving ample room for any style of expansion joint desired, or small cores could be taken. In the latter case, however, too much section would have to be broken out by hand. With one large core only sufficient edge distance would be required to prevent the breaking out of the concrete, which would affect the operation of the shot.

A Water-Heating Attachment for Concrete Mixers, which operates by forcing steam through the water entering the mixer, is shown in its component parts in the accompanying view. The left-hand part is screwed to the water-supply pipe, and the right-hand part screwed into the cone-shaped cap. Steam enters at the right. In operation the steam is forced through horizontal and vertical holes in the interior cone and passes through the water which flows in a thin stream over the cone. The upper end of the heater can be



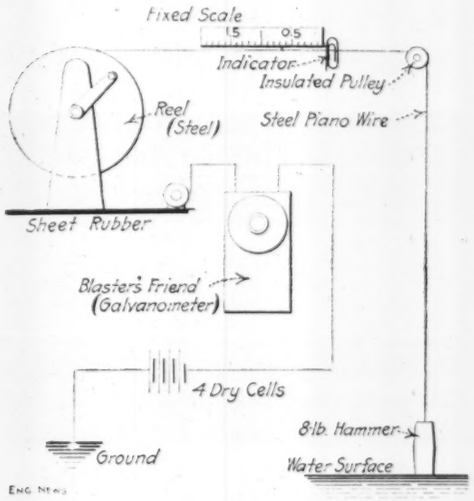
attached directly to the mixer or to a pipe line leading thereto. The device is to be used to heat water for concrete to be laid in cold weather. It is made by the Warner-Reiss Sales Co., of St. Louis, Mo.

A Device for Measuring the Inflow of Water into shafts has been used by the Board of Water Supply of New York, in the Hudson River shafts of the Moodna-Hudson-Breakneck siphon of the Catskill aqueduct. The method consists in lowering a steel wire to contact with the water, thereby completing an electrical circuit, the time and location of the closure being observed by means of the apparatus shown in the drawing.

An ordinary steel reel, such as has been used in tunnel alignment work, on which has been wound a suitable length of steel piano wire graduated in 50-ft. units, is insulated by

...ry wood, a sheet of glass or rubber. An 8-lb. hammer is ...sed, suspended endwise, as a weight to straighten the kinks ...n the piano wire and to give a good contact with the wa...er. The wire was graduated while under stress of this ...eight, the graduation being marked on ellipsoidal pieces ...f solder molded on the wire. The reel is grounded through ...galvanometer. Four dry cells are connected in the circuit. The cells are encased in a box, on top of which the galvanom...ter is fastened, so that the whole can be quickly set up in ...onnection with the reel. An insulated pulley placed over the ...haft in which the measurement is made, a scale, a steel tape ...nd a few "Gem" paper clips, No. 2, complete the apparatus ...required.

In making an observation, the reel is set a convenient ...distance away from the insulated pulley, so as to give a hor...izontal stretch of wire along which the scale can be fixed for ...ate measurements and also to facilitate taping from a ...marker to the nearest 50-ft. graduation. The ground con...nection is made with the reel. The wire is then conducted over the insulated pulley and lowered until the galvanometer

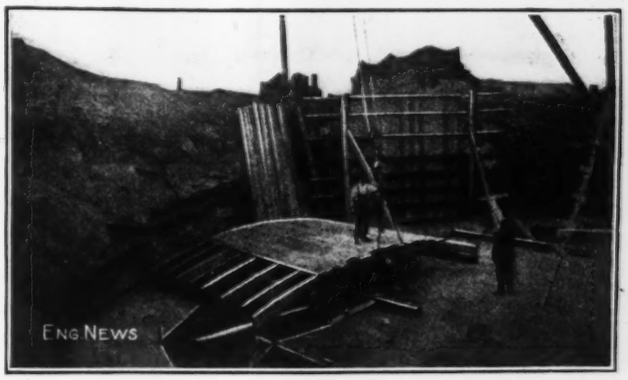


APPARATUS FOR MEASUREMENT OF INFLOW IN SHAFTS

gives indication that the weight is in contact with the water. By raising and lowering the wire and observing the action of the galvanometer the weight is set a trifle above the surface of the water. The time of contact is noted at which the water reaches the elevation of the bottom of the weight. In the meantime, a "Gem" clip (found to be the most effective temporary marker for use on the piano wire), is set on the vertical part of the wire at a known elevation and another on the horizontal part over a noted position on the scale. A rate measurement is obtained by raising the weight after it has been thus set, a distance measured by the movement of the second marker over the scale, clamping the reel and observing the time of a second contact. The elevation of the water surface is readily obtained by taping from the first marker set to the nearest 50-ft. graduation. This may be done after a series of rate measurements have been made and all the elevations are known from a single taping and the observed distance on the scale.

The method is, of course, also applicable to a falling water surface and will be used in leakage measurements during the hydrostatic test. Its advantage over a float or sounding bell is its great accuracy due to the fact that the time only must be observed at the instant of measurement; the distance for a rate can be set at leisure during the period of rise or fall and the elevation can be determined at any time. The degree of accuracy of this method is as great as the variation in waterway section warrants.

Simple Concrete Forms for the interior face of the walls of a circular concrete reservoir are shown in the accompanying view. The reservoir for the water-supply of Pleasantville, N. Y., is 75 ft. in diameter and 16 ft. deep. It consists of gravity-section plain concrete walls, 2 ft. thick on top and battered on the inside 10 in. in the 16-ft. depth and sloped on the outside so as to give a bottom width of 10 ft. The excavation was in side hill, so that the outside face forms could not be standardized, but for the inside forms the two sections shown in the view were built and used for the entire circumference

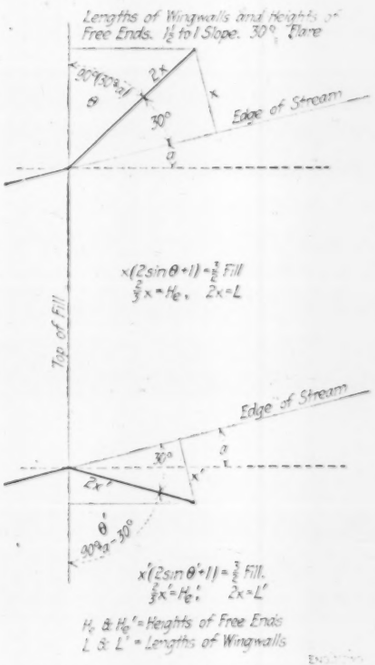


FORMS FOR INSIDE OF RESERVOIR WALL, PLEASANTVILLE, N. Y.

These forms are made up of 1½x6-in. spruce lagging nailed to 3x12-in. yellow-pine ribs, cut to the proper circle and spaced 2 ft. c. to c. for the bottom ribs and 3 ft. c. to c. for the top ones (pressure less). The ribs are cleated together by rough 2x10-in. spruce plank. The view shows one form in place and the other being raised into position by the one derrick that handled the forms for the whole wall. All of the lagging had not been nailed on at the time the view was taken.

In construction, the two forms were put in place and braced back against the edge of an opening purposely left in the concrete floor, which was first completed except for these openings. Concrete was then deposited behind the two forms, and an indent joint with extending reinforcement left at the end planes; the first form was then picked up and swung into place beyond the other and the process continued around the wall.

Hughes & Gardiner, Tarrytown, N. Y., were the contractors and the Lippincott Engineering Co., New York City, the engineers.


Lengths of Wingwalls and Heights of Free Ends. 1½ to 1 Slope. 30° Flare
Edge of Stream
Top of Fill
Edge of Stream
H₂ & H₂' = Heights of Free Ends
L & L' = Lengths of Wingwalls
ENG NEWS

FORMULAS FOR LENGTH AND HEIGHT OF ABUTMENT WING-WALLS, FOR SKEW CROSSINGS

Length and Height of Wing-Walls — The State Highway Department of Pennsylvania uses simple formulas for length of wing-walls and height of wall at free end, for bridge abutments. They are given by H. D. Buckwalter (Harrisburg, Penn.) in the diagram below, which applies to both sides of a skew crossing. The formulas are so simple that tables have not been computed from them; tables would be long, on account of the many skews and many heights of fill occurring in practice.

In the case of a square crossing the formulas simplify to the following:

Length = 1.1 Fill
End height = 0.366 Fill

in which the 1½:1 fill slopes and 30° flare of wing-wall are assumed the same as in the diagram.

Fifth Root by Slide-Rule—The following method of getting fifth root on an ordinary slide-rule has been used by Prof. W. S. Pardoe, University of Pennsylvania, Philadelphia:

Approximate the fifth root from the fourth root (the latter found by twice extracting square root). Opposite the original number on scale A set on scale B the approximated value of the fifth root. Note what the index of scale C reads on scale

D, and set the runner to read this figure on scale A. If the reading under the runner on scale D is the same as that under the whole number on scale B (i.e., the same as the estimated fifth root), then the estimated value is correct. If not, slide and runner must be shifted until the values in question are equal.

This process is a trial procedure, since it amounts to dividing the whole number by the estimated fifth root, then extracting the fourth root of the quotient, and comparing this with the estimate.

Prof. Pardoe has used this method for some time, in hydraulic calculations which involve fifth roots.

So far as we know this method (as well as all other trial-and-error methods) is not described in handbooks. It is better than reading the logarithm off the back of the slide and dividing it by five to get the logarithm of the fifth root. If other methods are known and in use we will be glad to hear of them.

The Graphical Method for Dividing the Neutral Axis of an arch given by F. P. McKibben, in Taylor & Thompson's "Concrete," and again described by T. A. Smith in "Engineering News" of Sept. 25, 1913, p. 611, is used in modified form in the Engineering Department of the Pittsburgh & Lake Erie R.R. Co. Donald P. Maxwell, in the office of the Chief Engineer, describes the method as follows:

A template is prepared as shown by Fig. 1. The construction of this is obvious.

The curve of I (moment of inertia) is plotted on cross-section tracing cloth. This curve is placed over the template and shifted so that the vertex of the template is on the curve and the triangles formed by the template and axis of ordinates are isosceles. This is rendered easy by the cross-section lines.

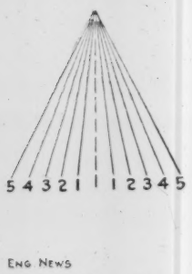


FIG. 1

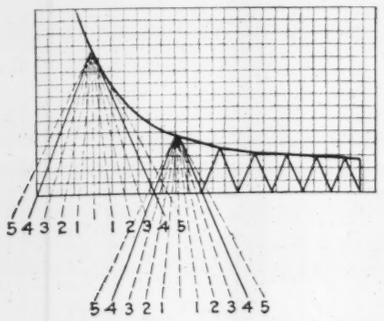


FIG. 2

Suppose the pair of lines marked "4" (Fig. 2) cut the base in about the length desired for the first segment when the curve is superposed on the template, as indicated at the left of Fig. 2. Mark this length on the axis. Shift the curve on the template to the second position shown in Fig. 2. Again mark where the line marked "4" cuts the axis. Continue this process until the end of the neutral axis is reached. If it is divided without remainder, the length of the first segment was correctly assumed. If not, choose another pair of lines on the template and repeat.

This method will be found a great time saver; it also reduces confusion of lines if many assumptions are necessary.

Traveling Tower Cranes for Building Erection—The cranes described in our issue of Oct. 23, 1913, p. 814, we stated were invented by Karl Voss. The firm of Voss & Wolter, Berlin, now writes that Voss was not the inventor; the firm bought the patents. These cranes are patented the United States also. We would refer, in addition, to article in "Engineering News," Dec. 5, 1912, p. 1034, 19 describing traveling tower cranes used in England, built Herbert Morris & Bastert, Loughborough.

Two Sides and Included Angle Formula—For solving t angles when two sides and included angle are given, Pr A. H. Stang (Delaware, Ohio) gives the novel formula

$$\cot B = \frac{a}{b \sin C} - \cot C$$

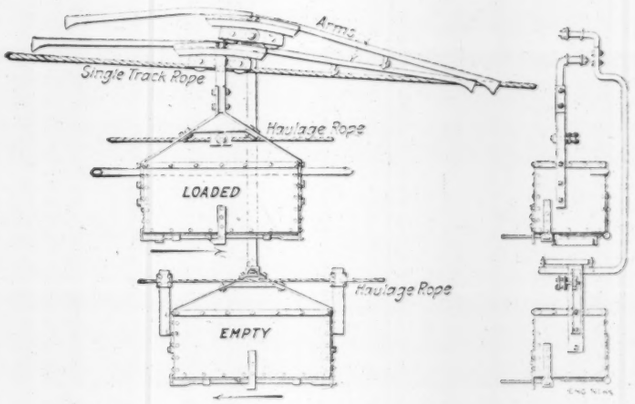
It saves much labor and time over the formulas for su and difference of angles. It may be derived from the sim sine formula (which involves the two opposite angles) b substituting for one of the angles its equivalent in term of the other opposite and the included angle.

The form

$$\tan B = \frac{b \sin C}{a - b \cos C}$$

has been given before, but Prof. Stang's expression, which i equivalent to it, is more convenient in use.

Device for Passing Cars On a Single-Track Cableway—A cableway of unique design at the Fosas mine in Sardinia, is desc ibed in the Nov. 29 issue of the "Engineering and Mining Journal," by E. Praetorius. Its novel feature is the device permitting two buckets to travel in opposite directions on the same rope. To the carrier of each bucket are attached two arms extending parallel to the track cable and above it. These arms are pivoted over the carrier, the one on the ascending side being kept elevated above the rope by means of a flat steel spring, while the arm on the descending side overlaps the rope and forms the track for the carrier coming in the opposite direction. The design of the buckets and carriers is shown in the accompanying illustration.



DEVICE FOR PASSING CARS ON A SINGLE-TRACK CABLEWAY

Daily Reports of Pipelaying are kept by each foreman in the Bureau of Distribution in the Department of Water of San Diego, Calif. The heading of one of the blanks used for making these reports is reproduced herewith. The daily reports are used, with other material, for compiling the monthly reports covering all the operations of the Water Department, and these in turn are used in making up the annual reports. We are indebted to H. A. Whitney, hydraulic engineer of the San Diego Water Department, for the form here reproduced.

H. R. FAY, Supt. H. A. WHITNEY, Hyd. Eng.

DAILY REPORT OF FOREMAN OF CONSTRUCTION

Bureau of Distribution Department of Water San Diego, California

Date ..... Foreman of Construction .....

Valves and Hydrants	Size and Amt. Pipe Hauled	Pounds of Castings Laid	No. of Men Ft. of Excavation	No. of Men Ft. of Backfill	No. of Men Joints Caulked	No. of Men Ft. Pipe Laid	Amt. Lead, Yarn and Oil Used	REMARKS

ENG. NEWS

REPRODUCTION OF CONSTRUCTION FOREMAN'S DAILY REPORT, SAN DIEGO WATER WORKS

(The original was printed on a filing card 8 in. wide and 5 in. high, with 12 lines for the record.)

EDITORIALS

A newspaper report comes to us describing a new short '(two weeks') course in Highway Engineering at the University of Illinois, intended particularly for the new county and town highway superintendents created by a recent law. We are told that the instruction will be absolutely free and that there will be three "semi-technical lectures" each day and one "semi-popular lecture" each evening—something for the whole family if only the gap (?) between the two varieties were bridged!

⁂

A striking illustration of the value of water meters is afforded by the fact that the water consumption of the Metropolitan Water District of Massachusetts (Boston and vicinity) was less for November, 1913, than for any other November since 1900, notwithstanding the increase in population in the last 13 years. Without meters, costly enlargements of the water system would have been necessary. The result attained must afford great satisfaction to Dexter Brackett, who, in the service of both the old Boston water department and the Metropolitan Water District, has long and ably advocated the use of meters and supported his advocacy by studies and reports which are classics in their field.

⁂

The Hudson Bay Railway

We have several times commented in these columns on the waste of public funds which Canada is making in its prosecution of the Hudson Bay Railway enterprise. It is another excellent illustration of the way in which public money is squandered because of the failure to call in and heed expert opinion. It is recognized by intelligent men in Ontario and Quebec at least, we believe, that the Hudson Bay road will be a hopeless financial failure; yet its construction is held to be necessary to satisfy public opinion in the Northwest, which is wholly distrustful of the Eastern provinces and believes that all criticism of the Hudson Bay project is inspired by those who fear that the flow of the grain traffic from the Canadian Northwest to Europe would be diverted from its present routes.

The Montreal *Gazette*, of Dec. 1, publishes a terse comment on the Hudson Bay enterprise, by Sir William Van Horne, which is worth reprinting.

"I am in favor of the Hudson Bay Ry.," Sir. William said to the interviewer, "because," he added, grimly, "it will not cost much, and also because it will settle in the public mind the question of transportation in that direction—definitely. In my opinion, the Hudson Bay route will not take out to Europe 20 cargoes of grain in 20 years."

Doubtless Sir William's criticisms will fall on deaf ears and it will be said that he is a prejudiced critic by reason of his long connection with the Canadian Pacific Ry. The indications are, however, that in no very long time Canada will be compelled to heed the voice of some of the conservative critics within her own borders.

It is often possible to create a fictitious prosperity by mortgaging the future for the sake of the present, or, in other words, raising large amounts of money by bond issues for great public works, municipal, state or national. Where such public works yield a return commensurate with their cost, the wisdom of such a policy is, of course, justified; but where the borrowed money is spent with little or no return, the community or the nation soon finds itself struggling under a load of debt and with no income to meet it.

The indications are that a very considerable part of the railway construction enterprises in Canada into which so many millions of capital have been poured during the last half-dozen years, will be a very long time in finding traffic sufficient to make them pay. It is instructive to note in this connection that a large issue of Canadian Government 4% bonds just put on the market in London has been left on the hands of the underwriters, only 17% being subscribed for by the public.

⁂

A Wrong Way to Aid the Panama-Pacific Exposition

We referred in our issue of Nov. 6 to the Kahn law, recently enacted by Congress, for the avowed purpose of inducing foreign owners of patented and copyrighted articles to make exhibits at San Francisco. As we then showed, this law makes any American manufacturer or publisher who may infringe upon any foreign patent or copyright upon any article exhibited at the Panama Pacific Exposition, liable not merely to a suit for damages and an injunction, as in the case of an ordinary United States patent or copyright, but liable in addition to fine and imprisonment.

At a hearing before the House Committee on Patents last week, Secretary Bryan is reported to have opposed the movement to repeal or amend the Kahn law, on the ground that foreign exhibitors had already made arrangements to make exhibits at San Francisco because of the conditions which the Kahn law contained.

This seems a very poor defense. Had the Kahn bill been fully understood by Congress or by the public, its enactment into law would never have been possible.

Apart from the features above referred to, a further serious objection to the Kahn law is that it offers to any holder of a foreign patent or copyright who shall merely exhibit the articles so protected at San Francisco, far more complete protection than is furnished under the United States laws to the holder of a United States patent or copyright.

As the Kahn law now stands, it is possible for an American inventor who holds foreign patents, to obtain this unusual privilege on the same terms as a foreigner. But by an amendment to the Kahn law, introduced on Dec. 11, in the House of Representatives, this privilege is withdrawn, and foreigners alone are permitted to take advantage of the Kahn law's privileges. It is true that this amendment contains other clauses which are intended to neutralize the iniquitous features of the Kahn law, but the liability to fine or imprisonment of any per-

son who wilfully aids or abets in copying any of these foreign exhibits, is still retained.

It seems to us that if the promoters of the Panama-Pacific Exposition wish to cultivate the friendship and good will of American manufacturers and publishers, they should make no further opposition to the entire repeal of the Kahn law. There could be no reasonable objection to a law giving to exhibitors at San Francisco of articles protected by foreign patents and copyrights, the further protection of the United States Patent and Copyright Laws with expense; but it is wholly unjust to grant them privileges which no American inventor or author can possibly obtain.

San Francisco Wins Its Long Hetch Hetchy Fight

The signing of the Hetch Hetchy bill by President Wilson on Dec. 19 brings to a happy end some ten years of effort on the part of San Francisco to obtain needed Federal rights to impound in the Hetch Hetchy Valley and to convey to the city an unsurpassed gravity mountain water-supply from the headwaters of the Tuolumne River. The evolution of the plans for this water-supply by former city engineers, C. E. Grunsky and Marsden Manson* and finally by John R. Freeman, has been one of the most interesting and notable achievements in engineering investigation and design ever recorded (see long illustrated abstract of Mr. Freeman's report, ENG. NEWS, Dec. 26, 1912.)

The fight to prevent the city from carrying out the successive plans has been strong and conducted with much bitterness and various kinds of misrepresentation. The long years of delay have given an opportunity which has been ably utilized to work up a more comprehensive and economical plan than those which were at first proposed. The present plan includes a supply for the whole San Francisco metropolitan district instead of for San Francisco alone; and in place of no power development, or only enough to be used to pump the water-supply over elevations, a vast amount of power is provided for and none of it will be required for pumping. Some of these notable changes in plan have been made feasible through the added time and funds available for engineering studies; some are due to advances in engineering practice, especially in the use of pressure tunnels; and some are due to brilliant engineering conceptions and boldness and ability in engineering design.

The fight against the Hetch Hetchy plan was fourfold: (1) The Spring Valley Water Co., which supplies San Francisco with water; (2) various other interests which wished to sell water or water-rights to the city; (3) the Modesto and Turlock Irrigation districts; (4) those who wished to preserve the portion of the Hetch Hetchy Valley (a part of the Yosemite National Park) which will be flooded by the reservoir and who claimed that in addition to the flooding of this rock-walled meadow the sanitary protection of the drainage area would lead to the exclusion of visitors from this part of the park.

In the process of time and with a variety of changed conditions, including the prospect of municipal purchase of its works, the opposition of the Spring Valley Water Co. is believed to have ceased. Most of the other water interests finally gave up the fight as hopeless. Agreements as to water-rights and water-supply also resulted in the cessation of opposition from the authorities of the irrigation districts—although, probably fostered by the fourth division of the enemy, there continued to be opposition, or reports of opposition, from some of the land owners in the irrigation districts.

The fourth source of opposition was unceasing to the end. The so called "nature lovers" appeared in considerable force before congressional committees, conducted a publicity campaign and secured a large amount of editorial support from the public press. This campaign was notable for zealous and well meaning advocacy of its cause, but equally notable for the partisan character of many of the statements made and for gross though perhaps wholly unintentional misrepresentation regarding the effect of the Hetch Hetchy reservoir upon the park and the merits of San Francisco's claims to the use of water and power from the Tuolumne River.

It would be profitless to discuss further the contentions of the nature lovers and their newspaper supporters, but it seems worth while to put on record the summary of their case and that of San Francisco and its allies as it appeared to President Wilson when he signed the bill:

> I have signed this bill because it seemed to serve the pressing public needs of the region concerned better than they could be served in any other way, and yet did not impair the usefulness or materially detract from the beauty of the public domain.
>
> The bill was opposed by so many public spirited men, thoughtful of the interests of the people and of fine conscience in every matter of public concern, that I have naturally sought to scrutinize it very closely. I take the liberty of thinking that their fears and objections were not well founded.
>
> I believe the bill to be, on the whole, in the public interest, and I am the less uncertain in that judgment because I find it concurred in by men whose best energies have been devoted to conservation and the safeguarding of the people's interests, and many of whom have, besides, had a long experience in the public service, which has made them circumspect in forming an opinion upon such matters.

The people of San Francisco voted (30,000 to 1200) $45,000,000 of bonds for the Hetch Hetchy works in 1910. Within a few weeks the Supervisors passed an ordinance authorizing condemnation proceedings for the acquisition of a portion of the property of the Spring Valley Water Co. Oakland and other near-by cities have given evidence of intention to join San Francisco in forming the Metropolitan Water District already authorized by the California legislature. Altogether, then, the prospects are bright for the early beginning of construction of one of the greatest water-supply and hydro-electric power systems ever built and one which has also promises of great benefit to some of the irrigation districts of California.

Secretary Lane on Conservation

The annual report of Hon. Franklin K. Lane, Secretary of the Interior, made public on Dec. 24, is of great interest to engineers, since most of the matter discussed in the report relates directly to work with which engineers are concerned.

There has existed for some eight or ten years now, more or less of a deadlock between the Executive Department of the Federal government and Congress with respect to the treatment of the nation's resources. The

*Some months ago Mr. Manson was succeeded as city engineer by M. M. O'Shaughnessy, who has since been active in Hetchy Hetchy affairs.

Executive Department has put an end to the former practice, under which the public lands of the nation with their accompanying mineral rights, forests, water power, &c., were given away or sold at nominal value to the first person who chose to appropriate them; but the recommendations of the Executive Department that Congress enact legislation to provide a better and more just means of transferring natural resources from public ownership to private ownership have generally failed of enactment. To a considerable extent, therefore, the development of natural resources in the far West and in the territories has been at a standstill.

It now appears extremely probable that this long-standing deadlock will be broken. The present Administration appears to have the support of Congress and to be able to have its recommendations enacted into law to an extent to which Washington has been for a long time a stranger. It is for this reason that especial importance attaches to the recommendations of Secretary Lane just made public.

The Secretary's report opens with a brief discussion of the deadlock to which we have referred. He alludes to the general dissatisfaction throughout the West with the policy of locking up the nation's resources. Rehearsing the history of land appropriation and exploitation in the West, he declares that in his opinion the West no longer asks a return to the old policy of giving away the nation's wealth, but *it does ask action.* "The West is reconciled," says the Secretary, "to the Government making all proper safeguards against monopoly and against subversion of the spirit of the land laws." What the West desires is "that all suitable lands shall go into homes and all other lands shall be developed for the purpose which will make them of greatest service."

The place where the results of Congressional inertia are most evident is Alaska. The population of that territory is now only 40,000, whereas according to the Secretary the land of Alaska is capable of producing by agriculture all that can be raised in the Scandinavian countries, where a population of 9,000,000 people is supported in Norway, Sweden and Finland. It has been estimated that there are 50,000,000 acres of this land "which will make homes for a people as sturdy as those in New England."

After thus reviewing the deadlock in Alaskan development, and the possibilities which proper exploitation might bring to realization there, the Secretary proposes a plan of development as follows:

> We have withdrawn Alaska from the too aggressive and self-serving exploiter. What have we to substitute as a safer servant of public interest? To this question I have given much thought, and my conclusion is that if we are to bring Alaska into the early and full realization of her possibilities we must create a new piece of governmental machinery for the purpose. We should undertake the work in the spirit and after the method of a great corporation wishing to develop a large territory. In my judgment the way to deal with the problem of Alaskan resources is to establish a board of directors to have this work in charge. Into the hands of this board or commission I would give all the national assets in that territory, to be used primarily for her improvement—her lands, fisheries, Indians, Eskimos, seals, forests, mines, waterways, railroads—all that the Nation owns, cares for, controls, or regulates. Congress should determine in broad outline the policies which this board in a liberal discretion should elaborate and administer, much as is done as to the Philippines. This board would, of course, have nothing whatsoever to do with the internal affairs of the organized Territory of Alaska, for it would exercise no powers save such as Congress granted over the property of the United States in Alaska.

We need not take space to print here the reasons which the Secretary presents in support of his proposition. We need note only his reference to the impossibility of efficiently administering the affairs of Alaska at a point 5000 miles away, separated from Alaska by an ocean and with communication cut off for half the year.

Of course, the argument will be made that to bestow such large powers upon such a Board would inevitably yield to favoritism, corruption and graft, but upon this point the Secretary very pertinently says:

> The members of such a board appointed by the President would be selected presumably with reference to their fitness of the work to be done. Each one could be made the administrative and resident head of a department or division, so that one might be a Commissioner of the Land Office, another a Commissioner of Highways, and so on; all would fit together as in the Commission form of municipal government. I apprehend the fear that with such a Commission there would be danger of corruption or indifference creeping into this work. This, however, is incident to the control of all authority. No method has yet been invented by which dishonesty or poor judgment can be guarded against in public or in private life. In the end the character and wisdom of the men appointed is the only insurance that can be given against conduct that is foolish or worse.

Secretary Lane, however, does not propose to await the organization of such a board under Congressional authority before proceeding with Alaskan development. He urges in the strongest terms, first, that the Government should immediately undertake the construction of a system of railways in Alaska, and second, that the Alaskan coal lands be opened for use.

As most of our readers are doubtless aware, President Wilson has already recommended that the Government should build and operate railways in Alaska. What Secretary Lane says in favor of the proposition has additional weight by reason of his previous service on the Interstate Commerce Commission. The Government already owns and operates on the Panama Isthmus one of the busiest lines of railway in the world. The new railway system now being constructed in the Philippines is also to a considerable extent under Government direction. There is, therefore, considerable precedent for the proposal that the United States should proceed to build and operate railways in Alaska.

Secretary Lane justifies the policy of railway building in Alaska, however, by the following three arguments: First, the Government is already building wagon roads in Alaska, a railroad "is little more than an operated wagon road" and a wagon road, if well built, is almost as costly as a railroad. Second, judging by past experience, there is little prospect that private railways will be built in Alaska, unless the natural resources of the country are largely surrendered to private control. Third, Alaskan railroads ought to be built and operated, not as purely money-making enterprises but for the development of the country, so that they could be operated at a loss, if need be, for a time until traffic develops.

To secure the development of the Alaska coal fields, Secretary Lane urges the adoption of a leasing system. He favors a similar system for opening the deposits of coal, petroleum, phosphate and potash in the West.

Doubtless the matter of most interest to the engineering profession in Secretary Lane's report is his opinion regarding the Reclamation Service. Elsewhere in this issue we have reprinted his chief recommendations regarding irrigation development, so we merely note here that he gives his hearty support to the work of the Reclamation Service. He speaks with strong disfavor of the

Carey Act plan, under which the Federal government has turned over lands to the States to be irrigated by private enterprise; but he commends in high terms the carrying on of Federal reclamation work in coöperation with the states concerned. The fact has already been recorded in these columns that preliminary steps have already been taken for coöperative irrigation work with the states of Oregon and Washington.

Turning finally to the much discussed subject of water-power development on Federal lands, the Secretary declares himself in favor of liberal grants to private capital. His position may well be shown by quoting the following extracts:

> Are we justified in measuring the value of the land for a water-power site by the use to which it is put, or should we yield this strategic resource without compensation? The country has been aroused too late to save the very richest of these points of vantage. Private power companies hold the most accessible of these sites under rights of which they can never be deprived. So much more compelling the reason why we should not yield what remain unwisely. The temptation to generously grant without condition that which may be put to so beneficent a use must be resisted if we are not to meet a spendthrift's fate.
>
> There must surely be a rational way by which private capital may be brought into this public service. The present condition of stagnation does no one good. Within a generation, I believe the people will be as alive to the value of public ownership of hydro-electric power plants as they are today to municipally owned waterworks.
>
> The people not being prepared, however, to proceed to put these lands to their highest use, I am not in favor of keeping them from being utilized by private capital in the public interest.
>
> What may capital reasonably demand? A fair and attractive return upon its investment yearly, and the full return of its capital. And what may the public served reasonably require? Good service and fair rates. Who shall make these rates? Within the State they must be subject to State regulation. Between the States, Federal authority must control.
>
> What return shall the Federal government have for its land? My answer would be, No returns whatsoever; provided the plant reverted to the Government without cost at the end of 50 or 60 years, or so much of the plant as was used on the land itself, and the improvements directly attached thereto, such as reservoirs, dams, water rights and rights-of-way. For the tangible property of the plant, such as the distributing system and machinery, the Government might well agree to pay an appraised price so as to insure its being maintained and extended during the later years of the life of the franchise. The right to buy the complete plant at an appraised figure at any time after 20 years would be a further protection and one not burdensome, while for better service it would seem advisable that all plants be permitted, in fact encouraged, to physically combine, just as our railroads are required to couple themselves into through routes and thus make their service continuous and interdependent; but they should not be allowed either to agree as to rates or to merge their capitalization or their identity.

We believe that Secretary Lane's recommendations will on the whole receive the general approval of engineers. This will be especially the case, because with the general stagnation of engineering activity which has characterized the last few months, it will be of great advantage if some of the hindrances to the development of natural resources in the West and in Alaska are removed. We see no reason why a program of Government railway construction in Alaska, an open door to mineral development under reasonable conditions, both in Alaska and in the far West, and an open door also to the development of water-power projects there, coupled, of course, with reasonable and sensible provision for the protection of the public interests, should not be as popular in Congress as it will be with the engineering profession.

LETTERS TO THE EDITOR

Paying for Concrete According to Its Strength

Sir—The recent failure of a reinforced-concrete structure at Cedar Rapids, Iowa, again serves to emphasize the need for better protection to all parties concerned. While this failure was probably due to premature removal of the forms, yet it tends to make the general public distrustful of reinforced-concrete construction. Any method that will insure greater certainty of getting good work should be adopted.

In designing a structure, more stress should be laid by the designer in his plans and specifications on the ultimate strength of the concrete which he assumes as a basis for his design. In other words, if the designer specifies a 1:2:4 mixture and expects to get a product that will show an average compressive strength on a 28-day test of 2000 lb. per sq.in., he should make a plain statement of that condition on his plans and in his specifications. Then to make sure that he is getting a concrete of the specified strength, provision should be made for frequent testing of samples taken from the work at various times during its progress. In this way the designer would be able to see how much strength the concrete was developing.

When it is realized that the strength of concrete is influenced by a good many different factors besides the main ones of proportions of mix and quality of cement, and that two different constructors will get different results though following the same proportions and using the same cement, it will be better appreciated that compression tests made as the work progresses are a protection for all parties concerned in the design and erection of the structure. The value of a concrete is dependent upon its compressive strength. A concrete that will show on a 28-day test a compressive strength of 2000 lb. is worth more than one that only shows 1600 lb. per sq.in., although both may be made from same materials and of the same proportions. In the last analysis it is resistance that we want in concrete.

We are all ready to admit, for instance, that it is a good and equitable way to buy coal on the heat-unit basis. So it would be justifiable to buy concrete on the basis of unit resistance. In other words if a given mass of concrete will develop a strength of 2000 lb. per sq.in., it is worth more to the buyer than a concrete which will develop only a strength of 1600 lb. per sq.in. and consequently the contractor should receive a higher unit price for the stronger concrete. On the other hand, if the contractor's methods of mixing and using water and placing

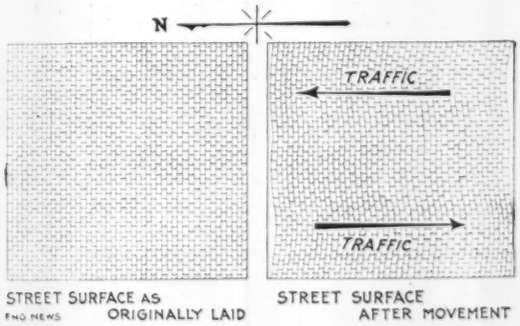
concrete result in a product that develops only 1600 per sq.in., he is not entitled to the same unit price as the stronger concrete. With frequent tests made during the progress of the work the contractor could be paid according to the resistance he gets in his concrete. In this way there would be a direct incentive throughout the job for the contractor to furnish the strongest concrete he could under the limits of the specifications. This would lead to greater care in the mixing, in the selection of material, in the percentage of water used and in the placing of the concrete. All these things would redound to the mutual benefit of the buyer, the contractor, and the designer, and insure greater safety of the public.

ROBERT C. BARNETT.

Kansas City, Mo., Dec. 13, 1913.

Creeping of an Asphalt-Block Pavement

Sir—The writer has noticed in your recent issues several accounts of the failure of street pavements, and was particularly interested in the account of the failure of the wood-block pavement, in Longview, Texas, described in the issue of Dec. 4, 1913, p. 1134. For some time he has observed the partial failure of a composition asphaltic pavement on Ocean Ave., Flatbush, Brooklyn, which, while not as spectacular nor as sudden as that at Longview, may nevertheless show another phase of the action of "block" pavement.



CONDITION OF ASPHALT BLOCKS, OCEAN AVE., BROOKLYN, BEFORE AND AFTER CREEPING

Ocean Ave. runs in a general north and south direction from Prospect Park to the ocean at Sheepshead Bay. The avenue is about 50 ft. wide and the section which has been noted in particular by the writer lies between Prospect Park and Avenue C, a distance of five blocks. The foundation of the pavement consists of from 4 to 6 in. of concrete and the surface is of composition asphaltic blocks 2¼ in. thick by 5 in. wide by 10 in. long. These blocks are laid on the flat with the longitudinal axis of each at right angles to the general direction of the street. The joints are broken in the usual manner. The blocks were undoubtedly laid originally while the concrete foundation was still soft as indicated by the markings made by the concrete base "squeezing" up between the joints. These markings are clearly discernible when the blocks are removed and were noted by the writer when certain repairs were being made.

On the west side of the avenue, these blocks have moved southward, that is, in the direction of the traffic, a maximum of 4½ ft. On the opposite side of the avenue the blocks have moved northward, also in the direction of the traffic, a maximum of 1 ft. In the center and along either curb, the blocks have apparently not moved at all. The general effect has been to make each row of blocks assume a large "S" shape where they formerly lay in a straight line.

The writer has been at a loss for some time to know what caused this movement. At first, it occurred to him that it might be the grade of the street but examination of certain stretches on almost a dead level showed the same characteristics, though less pronounced. Careful examination of the part of the roadway used most frequently by traffic led to the conclusion that it must have been caused by automobiles and automobile trucks. Of course, the grade tended to facilitate this movement, the blocks having been moved most in the downhill or southerly direction. Another reason the blocks moved more in this direction was that a number of heavy trucks go south loaded and back light. The action is undoubtedly similar to the creeping of railroad rails in the direction of traffic.

It is interesting to note that although the blocks slipped as much as 4½ ft., the joints did not open. In fact, the writer attempted to get some photographs but the joints were so tight that the dust on the street was sufficient to prevent their showing clearly. It is only fair to say that the laying of the blocks while the concrete was still green could in no way account for the phenomenon noted above, as the ridges of concrete squeezed up between the blocks would retard the motion rather than accelerate it. It is also only fair to say that the traffic is perhaps heavier than should be allowed on a surface of this kind. A wood block on even sheet asphalt would be better suited to the tax now being put on Ocean Avenue.

C. S. RINDSFOOS.
Secretary, The Foundation Co.
115 Broadway, New York City, Dec. 9, 1913.

Membership in the American Society of Civil Engineers

Sir—My letter "On the Value of Membership in the American Society of Civil Engineers," in ENGINEERING NEWS, of Sept. 11, 1913, has brought two public replies. I feel that I should, at least in part, answer these. In the letter of "Brother," ENGINEERING NEWS, Oct. 16, 1913, there is much to provoke discussion. Most of this discussion would be profitless and so I will not carry the personalities any further. The advice, information, problem in simple fractions and wonderful character reading of "Brother" are worthy of comment. However, I will take issue with him on but two points.

(1) I see no reason to be ashamed of having expressed my views in ENGINEERING NEWS. It is a good medium whereby a large number of the members of the Society may be reached; there is no secret in the actions of the Society and an honest criticism, even if unfounded, will do no harm.

(2) A careful study of President Swain's address (which has been read and much appreciated) develops the following:

> Finally let us inquire what the Society representing the engineering profession may do in the directions which have been suggested. We have been much criticized in the past as being inactive, as taking no part as a Society in large public questions. I must frankly confess that the criticism has

seemed to me in some measure deserved. Our Society is large, rich, influential, but we have been too content to sit down in dignified ease, taking little or no initiative, and allowing other and younger Societies to outstrip us in actual work performed and in real influence exercised.

I believe that we could and should go much further in these directions; that we should step forward and take the initiative and become a moving force in the community.

I am grateful to "Member Am. Soc. C. E." for his letter published Nov. 20, 1913. Both he and "Brother" have taken to heart my little attempt at humor at my own expense, for the dinner reference was so meant.

I did not say that my membership never helped me land a job. I asked if "reference to the fact that you are a member helps much when getting a position?" "Member's" optimism must please "Brother" who has such a strong nose for pessimism. However, I too have pride in my membership though I believe that the Society could be improved.

H. B. KIRKPATRICK.

1966 Lincoln St., Evanston, Ill.,
Dec. 15, 1913.

Long-Term Guarantees on State Highway Contracts

Sir—Your editorial on "Long-Term Guarantees on State Highway Contracts in New York" in your issue of Dec. 11, is very interesting. You do not mention, however, the chief difficulty in the way of long-term guarantees, that is, some guarantee on the part of the State as to the kind and amount of travel which will go over the road.

A guarantee of five years could easily be made on an asphalt pavement of reasonable width, traveled by pleasure automobiles or light horse vehicles. This same pavement would go to pieces if it were often traversed by 15-ton trucks or by heavy teams which travel in the same line over the road, making ruts.

Such improvement of roads as cutting down grades and making the surface better is followed by a materially greater total travel over the road and a much increased load per vehicle.

If any guarantee is asked for by the State of New York, it should be accompanied by a statement of the width of tire per unit of load permitted to go over the road; and a stipulation that no traction engines with rough wheels will be permitted on the road.

F. R. UPTON.

9 Clinton St., Newark, N. J., Dec. 15, 1913.

State vs. Federal Control of Natural Resources

Sir—Referring briefly to your comments of Dec. 11, in reply to my letter of Dec. 1, it must be admitted that you condemn Congress because of its prodigality in the administration and disposal of public resources. In the same editorial, however, you place State administrations on a lower plane for efficient administration. My contention is that there are no facts or reasons to justify this unfair comparison.

The immense railroad grants have been made through acts of Congress. The iniquitous transfers of cut-over lands (included within grants to railroads), for land scrip, have been made through the coöperation between railroad lobbyists and officers of the Forest Service and Interior Departments. If the resources you are so much interested in have been stolen or given away, we must hold the National government largely responsible. Why, then, is the argument favoring a more rigorous Federal control? Has it not been tried and found wanting?

You state that "conditions have changed and public opinion has changed too." Fortunately, this is true. Those who have been able to follow the practical application of a system which centralizes the administration of public resources at Washington, have about concluded that it is time to change "conditions." So far as we can see, State and National governments are supported by the same people. If we do not have confidence in the State government, how can we uphold the National government? Your editorial of Nov. 27 would lead the reader to believe that you entertain grave doubts as to the honesty of Western people generally. It would seem that, under this assumption, you would hesitate to entrust the responsibility of administering public resources to Congress, where all of these States are fairly well represented.

It is apparent to a careful reader that there must be some other reason for your apparent distrust of the States. Possibly you have local examples of State government in the East which are not inspiring. If this is true, it would be much better to permit the people of the West to work out their own salvation, rather than to compel them to deal with a National administration that may be contaminated by the examples which have established your convictions.

CLARENCE T. JOHNSTON.

Ann Arbor, Mich., Dec. 13, 1913.

Metal Flumes for Irrigation Canals

Sir—The article by F. W. Hanna on "Metal Flumes for Irrigation Canals," which appeared on p. 1077 of your issue of Nov. 27, 1913, is a noteworthy addition to the published data regarding structures of this type. Mr. Hanna has, however, not fully covered some features of the subject, and also inadvertently has given a wrong impression in some of his statements. Realizing that he would be pleased to have attention called to these errors, and knowing that ENGINEERING NEWS gives full and impartial consideration to the discussion of all technical questions, I beg to submit the following:

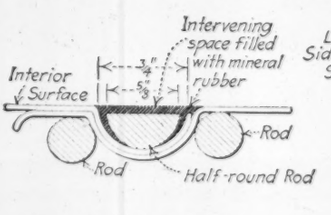


FIG. 1. CROSS-SECTION OF JOINT

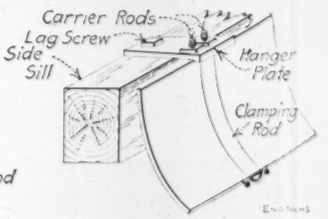


FIG. 2. JOINT AND HANGER

DETAILS OF LENNON METAL FLUME JOINT

In the third paragraph of Mr. Hanna's article, he has referred to three general types of semicircular metal flumes. He states: "(1) The rough interior type (Lennon), in which the metal sheet of the flume is corrugated transversely to the axis of the flume at regular intervals of a few inches." . . . As a matter of fact, the rough

...r Lennon flume has not been manufactured for ...than two years, and is not in general use, although ...giving satisfactory service on a large number of ir... ...tion projects. The smooth interior Lennon flume ...been on the market over two years, and the present ...non flume has the smoothest interior surface at the ...ts of any metal flume built.

The details of the joint of the smooth interior Len... ...flume are shown by Fig. 1. Provision is made in this ...sign for expansion at every joint by the use of a larger ...bead or corrugation along the edges of the transverse sec... ...than is afforded by an inside clamping bar. The ...intervening space around and above the inner bar of this ...joint is filled with a type of mineral rubber that is soft... ...by heat and yields to the pressure resulting from ...the longitudinal expansion of the flume. This also gives ...the flume an absolutely smooth surface at the joints as ...well as between the latter.

The conditions applying to the expansion of sheet metal of the gage usually employed in flume construction necessarily are different from those pertaining to structures built of heavy plates. The flexibility of the former does not permit it to carry a considerable end compressive stress any appreciable distance, such as is required to deliver expansion effect to a given point. Moreover, the resistance of metal sheets, of the gage used, to lateral bending is certain to occur under the conditions to which metal flumes are exposed, unless provision to take up expansion is made at frequent intervals. The joint of the Lennon flume most satisfactorily meets these conditions.

The type of joint illustrated in Fig. 1 also prevents the retention of water, sand or moisture between the lap of the sheets at the joint when the flume is not in service. The chief source of rust and corrosion at the joints is thus eliminated. This joint embodies another distinctive mechanical principle in distributing the load to two carrier rods at each joint, as shown by Fig. 2. At the same time, this joint construction prevents sagging of the sheets between the joints. Such sagging can occur only from deformation of bends or corrugations in the sheets at the joint under load.

Mr. Hanna in his article states, "in their catalogs the manufacturers use 0.015 for the Lennon and ——— types," referring to the value of n in Kutter's formula. He probably has referred to a catalog more than three years old issued by the Colorado Corrugated Iron Pipe Co. The coefficient of friction, n, in Kutter's formula is 0.011 for the Lennon metal flume. Other details of Lennon flumes of similar importance are unintentionally mis-stated by Mr. Hanna, owing to the catalog he apparently used as a source of information being entirely out of date.

A feature of erection not mentioned by Mr. Hanna is worthy of consideration. In erecting, the entire Lennon flume is put up, in large as well as in small sizes, with steel hanger plates at the joints. The necessity of bringing the carrier rods up through any timbers during the handling of the sheets is thus avoided. In smaller and medium sizes of Lennon flumes no cross bars are necessary. In some larger sizes, cross bars are spaced 4, 6 or 8 ft. apart, and in others the intermediate rod on each section is carried up through cross-beams of wood used to brace the side walls. The elimination of carrier bars prevents dams of weeds in smaller sizes, and in larger ones reduces the timber necessary for the structure.

Sectional metal intakes and outlets frequently are provided at both ends of a flume. These prevent the accumulation of too great an amount of water in the flume at its junction with the canal at the intake and also in the canal at the outlet of the flume.

Much attention is being given to the design and construction of steel trestles for metal flumes. The cost of such steel trestles in a number of average conditions has been about 50% more than that of timber trestles, based on a cost of timber of $40 per 1000 ft. in place.

The more efficient and economical construction of canals and flumes and the use of high-purity iron for the purpose of reducing rust and corrosion in the latter to a minimum are receiving unusual attention. These factors are certain to have a most beneficial effect on the irrigation securities market, which has suffered much in the past on account of crude, hasty and faulty construction.

THE LENNON FLUME CO.,
Wm. Lennon, Pres.

Colorado Springs, Colo., Dec. 6, 1913.

Sir—In the article on "Metal Flumes for Irrigation Canals," by F. W. Hanna, published in ENGINEERING NEWS, of Nov. 27, 1913, only one example of the "smooth interior type" of metal flume, which is now practically the only type manufactured to any extent, was mentioned. Among the smooth flumes now manufactured and extensively used is the wedge-joint metal flume, which possesses several interesting and unique engineering features.

Its joint (Fig. 1) is founded on the principle of wedging. The inner bar being in compression and the outer

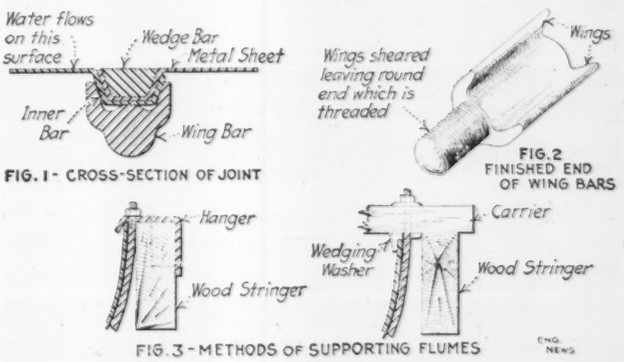


FIG. 1 - CROSS-SECTION OF JOINT

FIG. 2 FINISHED END OF WING BARS

FIG. 3 - METHODS OF SUPPORTING FLUMES

FIGS. 1 TO 3. DETAILS OF HINMAN METAL IRRIGATION FLUMES

bar in tension, the tendency is to wedge the metal sheets which compose the flume between the wings of the inner or wing bar. The greater this wedging the tighter is the joint. The groove in the inner sheet is smaller than the groove in the outer sheet so that the surface adjacent to the flow of water is in perfect alignment.

The bars are designed especially for the purpose for which they are used and it will be noted that the wing bar, being specially designed for stiffness and being placed on the outside of the waterway, will maintain the cross-section of the flume under various conditions of loading. This wing bar has a much larger moment of inertia than the ordinary round bar used in most flumes. Where round bars are used there is invariably

a very appreciable sagging or "egging," especially when the flume is under half or two-thirds capacity, making the center of pressure lower, and with this comes a corresponding leakage due to the distortion.

The treatment of the ends of the wing bar is shown by Fig. 2. The wings are sheared, leaving the ends round in section so that they can be threaded.

The two methods of supporting metal flumes noted in Mr. Hanna's article are also used in the flume just described and are shown in Fig. 3. The hanger method is used principally to leave the top of the flume free from obstruction of any kind, so that weeds or trash that may get into the waterway will pass through without clogging. This method, however, has several objections. First, the unobstructed waterway is obtained at the expense of alignment, as the hangers must necessarily follow the stringers and the action of the weather on the timbers will gradually twist and bend them until this alignment is destroyed, thus affecting the value of n and the capacity of the flume.

Again the hanger method is suitable only for small flumes. It can be readily seen that the weight of the loaded flume, transmitted to the stringers through the hangers, produces torsion in the stringers by means of which they tend to twist inwardly toward the waterway. These stresses can be neglected in small flumes, as the sizes of the stringers can be made such that they will not be noticed in the finished structure, but for large flumes these stresses and the direction in which they act are indeterminate, and in order to make sure of the structure the engineer must necessarily use such sizes of timbers as are uneconomical when compared with the carrier construction. This torsion in the stringers may be overcome somewhat by placing struts across the top of the structure at intervals of about 6 ft.

With the carrier method of support the weight is transmitted vertically to the stringers and the loading of the beam can be accurately computed. The alignment of the waterway is more nearly maintained, as the distance across the top is constant at each carrier. It is also true that the carrier method affords a more rapid means of rection.

Expansion and contraction have been neglected in the erection of most metal flumes during the last few years, as it has been demonstrated that this can be cared for if the flume is properly erected.

When the total movement of a given length of flume is determined for a variation of 130° F., it appears to be sufficient to warrant serious attention in caring for it, but when it is reduced to a single flume section of approximately 30 in., it becomes only about $^1/_{70}$ in. per section of flume. The damage done to flumes by temperature movements has, in most cases, been caused by permitting this movement of about $^1/_{70}$ in. per section to accumulate and concentrate its effort at one or two points, tearing the flume loose from a concrete intake or discharge structure or lifting the metal waterway from its substructure. This accumulation of movement can be prevented by securing each end of each carrier to the stringer on either side of the waterway by means of a large spike or bolt. This will force the stresses of expansion or contraction into each sheet, buckling or stretching it. This, owing to the very small movement, will never be detected in any way and will prevent any trouble.

As a matter of precaution, assuming that some of these spikes or bolts should become loosened, and also the only means of getting the connection between concrete structures and metal waterway absolutely watertight, it is strongly recommended that the ends of the flume be bedded in a groove filled with elastic cement. This cement, to be efficient under all conditions, must be non-inflammable, must not melt, freeze, run off, nor shrink, nor become hard and crack with age. In making such connection a groove from 4 to 6 in. deep and about 2 in. wide should be left in the concrete. This groove should be filled with the elastic cement and the end sections of the flume, prepared by cutting and bending at right angles to the flume, forced down into the cement, which will adhere to the concrete and the metal, making the joint tight.

Mr. Hanna's article states that it is desirable, in fitting the sheet-metal sections together, "to paint them at the joints, and also the rods and bars to secure water-tightness and prevent corrosion." In the writer's practice, all the bars, shoes, washers, etc., are dipped in heavy asphaltum coating before shipment, but the painting of metal sheets at the joints before assembling is never recommended because of the fact that in the field most any kind of paint is liable to be used for this purpose. This paint will probably be lumpy, or contain "paint-skin," and will thus prevent the grooves from nesting closely, resulting in a leak.

If painting is done at the joint it should be put on when the flume is all in place and the rods tightened. It will then work down into any small openings that may exist and form a film over the entire joint, thus doing more good than painting at the time of erection.

With the flume here described it is very seldom that any painting is necessary, as the wedging feature nearly always makes the joint tight, but even in sheets that appear to be smooth, there are occasionally places where the galvanizing will be just a little rough. This, though scarcely discernible, will permit a small dropping of water at this particular place in the joint and can usually be remedied by painting the inside.

L. R. Hinman,
Vice-Pres. and Mgr., Hinman Hydraulic Manfg. Co.
Denver, Colo., Dec. 12, 1913.

Making the Coat Fit the Cloth

Sir—The letter from John M. Goodell in your issue of Nov. 27 on "How Far Must an Engineer Be Guided by His Client's Resources?", touches a very vital matter.

When the writer was entering engineering work, the newspapers were filled with stories how malarial- and fever-ridden cities were being made sanitary by the use of "small drain pipes." Every newspaper editor was familiar with the subject, to judge from the editorials, and the name of Waring was on every tongue.

The principal argument used was that the separate system was less costly than the combined system of sewerage; and by using it, many small places where the costly combined system was impossible by reason of limited finances, would be enabled to install sewers and become healthy. The free discussion of the subject did more to advance the art of sanitation in this country than anything else. The engineer made himself a power in the councils because it was found that the more intelligent

better educated he was, the more money he could because of his ability to make a small pipe carry all sewage. It was about that time that the late A. M. Wellington, in referring to railway work, gave his classic definition of an engineer as one who could do well with one dollar what any bungler could do after a fashion with two.

If this is a good definition of an engineer, then the engineer is a saver of money, not a spender of money. It should therefore be his first duty when called in on a project to inquire into the financial ability of his client to carry out the necessary work. This having been ascertained, he should plan works fitted to the client's financial ability. This he can do and so explain that his client can understand it. If after a time the works are found inadequate, no blame can attach to him and if there is more money obtainable then more may be spent.

The writer has been often called in to consult with city officials and asked to prepare plans whereby certain very greatly needed improvements could be obtained with a less expenditure of money than other engineers recommended. In nearly every case it has been found possible to give the people something they urgently needed. The engineers first called in could have done this. Why they did not, no one could explain. The writer suggests the following reasons:

Usually a committee is appointed to undertake a public work. The committee employs an engineer and gives him instructions. But his judgment as to the wisdom of the project is not sought; he is employed merely as a specialist to prepare plans for a project which the committee assures him can be carried out. Until the committee's orders have been complied with, the engineer has nothing to say. Having prepared plans for the work the engineer awaits action from the people who pay taxes and who must vote on the matter. The people vote against the project on the ground of high cost. The matter is then up to the committee and the engineer is again called in, not as a hired man to carry out orders, but as an expert to tell the committee just what it should do and how it can do it. In the first instance the engineer was a skilled technical assistant of the committee. In the second case he is the competent adviser. He is then an engineer in the broader sense. It is essential that all engineers guide themselves as far as possible by the resources of their clients, remembering that a step at a time can readily be taken but a long jump is hazardous.

ERNEST MCCULLOUGH.

Monadnock Block, Chicago, Nov. 28, 1913.

[We should say it is not merely the financial resources of his client that should govern the engineer in making the design for any work. The client may be a very wealthy individual or corporation and the question will still be, how much is it worth while to spend? Will the spending of an additional hundred or thousand or ten thousand dollars yield enough return in better work or in reduced cost of maintenance to make it a good investment? Or, conversely, can a hundred or thousand dollars be pared off the cost here or there without injuring the completed work proportionately?

We admit that such questions seem simple and self-evident, and part of the manifest duty of an engineer in responsible positions to ask and answer. But we know of many instances in which business men distrust engineers and pin their faith to so called "practical" men; largely because of unfortunate experience with engineers who appeared to think that the question of cost was no part of their concern.—ED.]

The Bactericidal, Deodorizing and Physiologic Action of Ozone

Sir—I wish to refer to the article in your issue of Nov. 27, 1913, on "Recent Investigations of the Bactericidal, Deodorizing and Physiologic Action of Ozone," abstracted from a recent issue of the *Journal* of the American Medical Association, calling to your attention, that the manner in which these tests were conducted, leaves large room for doubt as to the reliability of the conclusions drawn by the authors, and that the readers of your valuable paper should be warned against accepting them without more convincing proof.

After a careful study of the reports, I am impressed that many of the conclusions are imaginary and not proven by the results obtained. For example, tests were made on three men by placing them individually in front of a large ozone generator delivering a strong blast of ozonized air at high concentration, the face of the victim being only a few inches from the outlet of the ozone generator. One of the victims had a "sore throat" ("cold") at the beginning of the experiments. The experimenters concluded from the results of the test that breathing ozone in strong concentrations produces sore throat. When we consider the probable effect of the blast of air on the face and head, the wind pressure on the nasal passages and the dust carried by the blast, it seems rather far fetched to make any definite conclusions regarding the effect of ozone, especially from such a small number of tests and subjects. Furthermore, the conditions of the tests were extremely abnormal as it has not been proposed to use in ventilation concentrations exceeding one-tenth of that used in these tests.

The results of the bactericidal tests indicate that ozone in dry air has little germicidal effect. There is, however, overwhelming evidence which proves beyond a doubt that it will destroy germs in water. This has been thoroughly tested out by the best scientific authorities in Europe in connection with the many municipal ozone water-purification plants. As there is always considerable moisture in the respiratory passages, it is perfectly logical to suppose that the breathing of ozonized air may have some beneficial effect.

The fact that the guinea pigs died in an atmosphere of strongly concentrated ozone is not surprising, as there is no substance known to science which will destroy bacteria without also destroying animal tissue. For this reason, antiseptics cannot be used full strength and the best that is expected from their use is to stunt the growth and prevent the propagation of the bacteria.

The tests on the animals in the cages supplied with mild concentrations of ozone showed practically neutral results, i.e., there was no pronounced beneficial or detrimental effects noted. The duration of the tests was entirely too short to be conclusive.

The test those experimenters made of blowing ozonized air on a piece of paper covered with lampblack to determine the effect of ozone on tobacco smoke, was going a long way around. It seems to me the proper way to

make such a test would be to make it on tobacco smoke instead of lampblack. Particles of carbon in lampblack are very many times larger than the floating particles of tobacco smoke and hence, the oxidation of the latter in its very finely divided state might take place when lampblack would not be appreciably affected.

W. H. THOMPSON.

Westinghouse Electric & Manufacturing Co.,
East Pittsburgh, Penn., Dec. 13, 1913.

[We have noted also the remarks of C. P. Steinmetz, Chief Consulting Engineer of the General Electric Co., on these studies of the American Medical Association, in the *Electrical World*, of Nov. 29, 1913. It is of interest to reprint these before commenting on Mr. Thompson's letter.—ED.]

While I personally do not like the smell of ozone and therefore do not care to have it about, nevertheless some of the conclusions reported by the experimenters appear to me inconsistent, so that it may be well to caution the reader against accepting them without further evidence. For instance:

Guineapigs were harmed and killed by a very high concentration of ozone, and from this the conclusion is drawn that an extremely low concentration of ozone is harmful. with the same reasoning, since guineapigs kept in pure oxygen are harmed and killed, the conclusion may be drawn that the 20 per cent. of oxygen contained in the air which we breathe is harmful and that we are all in imminent danger of death. Any corrosive non-poisonous agent in sufficient dilution becomes harmless, and while, for instance, the drinking of concentrated hydrochloric acid would be fatal, free diluted hydrochloric acid normally exists in our stomachs as an agent of digestion.

Also, the report states, ozone in higher concentration destroys odors, while in low concentration it "masks" them. It is hard to conceive, without very conclusive evidence, why the action of ozone should be different in one case from its effect in the other.

The experiments with bacteria described are hardly remarkable. I believe any chemist would have predicted that under the conditions of the experiment ozone should have no effect on bacteria.

Ozone is active oxygen, and as such at ordinary temperatures gives many of the reactions which ordinary oxygen exhibits at incandescence; that is, it oxidizes or burns combustibles, such as organic matter. Thus an oxidizable gas, such as the smell of a smoldering tallow candle and most organic smells indicate, should be destroyed sooner or later, depending on the concentration, while a non-oxidizable gas, as, for instance, that indicated by the smell of chlorine or nitric oxide, would not be affected by ozone.

As dryness interferes with chemical action, it should be expected that dry bacteria would be very resistant against ozone. As the action of ozone is oxidization or cumbustion, bacteria contained in jelly could be affected only by the complete destruction of the jelly. Or bacteria in drinking water containing large amounts of organic impurities could be destroyed only by quantities of ozone sufficiently large to burn up the entire organic matter. For this reason, in water sterilization by ozone, previous filtration is generally used.

In view of the rapidly increasing industrial application of ozone, on the one hand, and the many wild claims made for it by quacks and humbugs, on the other, it would in the interest of the electrical industry be extremely desirable if a comprehensive and impartial investigation on ozone and its industrial, domestic and medical use were made by a competent group of scientists. Such investigations, however, could not be carried out by men of one profession only without leading almost certainly to wrong conclusions caused by generalizations from special cases, as I pointed out above. A proper study of the problem, indeed, would require the coöperation of competent physicians, physicists and chemists.

In the literature of ozone at present there seems to be practically no statement which is not flatly contradicted by exactly the opposite statement made by equally high authority.

[It will be admitted, we think, by the experimenters of the American Medical Association that they would have been well advised had they secured the association of recognized sanitary engineers. However, as we view the studies, they were made judicially, carefully and [illegible] out animus; scrutiny of the report from a wholly biased viewpoint seems to stamp the majority of the test results as dependable and informing in spite of pointed criticisms which can be made of minor experiments, that were more or less foolish, like the [illegible] quoted by Mr. Thompson. These we did not consider worth including in our summary of Drs. Jordan and Carlson's work.

It is begging the question for critics to talk about the admitted possibilities of ozone in water treatment. In our editorial comment on the American Medical Association studies (also in the issue of Nov. 27, 1913) we emphasized the point that they had no bearing upon the various commercial uses of really concentrated ozone as a chemical agent under the usual safeguards. Dr. Steinmetz speaks of the "high concentration" from domestic machines. It should be noted, however, that these give mere homeopathic dilutions compared with the strengths, a thousand times greater, of mixtures used in water sterilizing, bleaching, etc.

Both of the criticisms which we reprint above obviously are not aimed at what seem to us the important lessons in these studies; (1) that treated air having any concentration of ozone of appreciable bactericidal or deodorizing effect has an injurious influence on higher animal life; (2) the stimulating effects of ozone are (a) a questionable sensory irritation and reflex brain stimulation quite like the tonic effects of ladies "smelling salts" and (b) an undesirable blood congestion in the respiratory areas with more or less corrosion of moist membranes.

It may not be out of place here to refer to still other criticisms which have been made on the American Medical Association studies and which we would expect could persist only in minds where the glamor of "ozone" and "electricity" had not worn off. We have been surprised to read, for instance, that ozone is "Nature's powerful natural oxidizing agent" and that "the hygienic advantages of mountain or ocean climates are due to the presence of small percentages of ozone in the air." We have yet to find a convincing basis for such imaginative conditions and we prefer to attribute the benefit of life on the ocean or in the mountains to the more tangible pleasures of pure air, sunshine, wind, exercise and scene.—ED.]

Pressure Tests on Concrete Pipe

Sir—The writer was much interested in reading the account in ENGINEERING NEWS, of Dec. 4, 1913, p. 1126, of pressure tests of joints of reinforced-concrete pipes, as the problem of designing a satisfactory pressure pipe in concrete is one to which he has devoted no little time during the last few years, both analytically and experimentally.

It is possible to produce an impervious concrete by a proper proportioning of proper materials. It is essential that the mixture be so introduced in the forms as to prevent segregation, and as you imply editorially the order of introduction of materials in the mixer is of less importance than thorough mixing. Such tests as those described cannot be considered conclusive as they are in the nature of laboratory tests—even when made on such large diameter pipe as 84-in. A joint which may show up well under the conditions described—the several sections being held together by tension rods—may fail [illegible]

y under ordinary working conditions when laid in round and the pipe subjected to uneven settlement the surrounding soil. Indeed, a joint such as used tests will not admit of any movement whatever and is practically true of any joint dependent entirely ement for a seal.

By far the most difficult problem in connection with concrete-pressure pipe is the reinforcement. It is an established fact that concrete under tension will crack when the reinforcing steel is stressed to from 5000 to 8000 lb. per sq.in. This low unit stress requires the use of a high percentage of steel and even then gives small margin for the higher stresses produced by water-hammer, from which few pipe lines are free.

Therefore, the writer came to the conclusion that to make a successful reinforced-concrete pipe, the circumferential reinforcement should not be placed in the pipe wall inert but under an initial tension equal to or greater than the assumed working stress. Using these principles the writer has made pipe which would show no leakage under pressure as great as 200 lb. per sq.in. and involving a working stress in the steel (wire) of 20,000 lb. per sq.in. and higher. The same pipes were subjected to pressure up to 400 lb. without serious results. Longitudinal cracks were of course produced at the latter pressure but they closed and were water-tight at 200 lb. and under. Furthermore, to show the impervious character of the pipe wall, it required sustained high pressure for long periods to produce even a show of moisture on the outside of walls having a thickness of but one inch. A coating of suitable bituminous material on the interior will effectually prevent seepage when the other precautions noted above are taken.

MASON D. PRATT.
1507 Continental Building, Baltimore, Md.
Dec. 12, 1913.

Thin Partition Walls in Reservoirs

Sir—I was much interested in the accounts which you published regarding the thin partition wall which failed in the water-works plant at Fort Smith, Ark. The failure at Fort Smith appears to be a direct condemnation of this type of construction.

Your second installment, in ENGINEERING NEWS, of Dec. 11, bears out your statement of Nov. 20. It appeared that a substantial division wall was needed; but there were insufficient funds for the purpose, so the "next best" thing was done—a baffle wall was designed whose existence depended upon the coolness of head of an $80 per month man. The inevitable happened. The report states that a stop gate had been fitted to the sewer outlet but not correctly set as yet, implying perhaps that had this been done the accident would not have occurred. But I firmly believe that it would ultimately have happened.

The factor of safety of physical man is in the hundreds, but mentally he is usually pretty close to full load, if not in fact overloaded. Hence, when unfailing steadiness and great care are expected from a low-priced man, someone is going to suffer. It is usually all parties concerned.

This particular instance is not of great moment but it illustrates a condition just as well as though it were another Austin Dam failure. Who is to be blamed—the designer—the Board—the people of Fort Smith? To my mind each must shoulder his quota of responsibility. The designer, the man to know, should not have lent his reputation to a project which he cannot defend, if to guarantee it was too much to ask. If such a wall was bound to be designed, he should have let someone else, someone in whom the public has less confidence, do it. As for its necessity, why should any community need any sort of a public work for which it cannot pay? The responsibility of the Board and people lies in this latter direction.

The accident, however, has not been in vain for from the débris of this baffle wall will arise, for future similar needs, an adequate division wall, costing if necessary $7000.

WALTER R. MASON.
40 Argyle Place, Arlington, N. J.,
Dec. 17, 1913.

Weight and Cost of London Motor Omibuses

Sir—Permit me to take exception to several statements made by you in the course of a recent editorial commenting upon John A. McCollum's very interesting study of motor-omnibus operation abroad, appearing in your issues of Nov. 20 and 27. It is important, in view of the applications for motor-bus franchises now pending before the public authorities in New York City and elsewhere, that no erroneous statements, even though quite unintentional, be permitted to gain currency.

You say in the course of your editorial that the weight of the London busses is restricted to about 5500 lb. You will find, I think, that the actual weight of the London bus is at least twice these figures, if not more. I have it on excellent authority that the London type of vehicle, which is similar to the bus operated by the Fifth Avenue Coach Co., weighs within a ton and a half of the electric storage battery bus recently exhibited on the streets of New York. As the weight of the latter is about 14,500 lb., your estimate of 5500 lb. for the London type of bus appears to be far under the correct figures.

You have likewise been too conservative in your statement in reference to the cost of the London type of bus, your figures being $2500 apiece. It may interest you to know that the very lowest prices quoted by the American representatives of the English and French manufacturers are approximately as follows: for chassis, $2600; body, $1000; tires, $300; or a total cost of very nearly $4000. As practically all the bus lines in successful operation in this country use vehicles imported from London and Paris, the prices quoted above represent actual trade prices on which business is being done right along.

I am also advised by one of the largest American bus companies that a bus equal in general efficiency to the London type of vehicle cannot be built in this country for much less than $5000. This explains why the busses driven on Fifth Avenue are all imported vehicles.

There is, furthermore, a serious error in the following sentence, which I quote from your editorial:

> In contrast with the large fixed investment necessary for the electric railway is the fact that the motor omnibus requires no investment whatever in the city streets, and the investment in rolling stock is probably little greater than the cost per passenger for an equal capacity in electric cars.

The facts in this connection may be briefly stated about as follows: the modern trolley car costs in general about $40 per passenger capacity. That is, an electric car with a capacity of 100 passengers costs about $4000. The gasoline-driven omnibus of the type used on Fifth Avenue costs from $5000 to $6000 and its capacity is 34 passengers, making the cost per passenger about $150 to $170. The London companies figure the cost per passenger at about $120.

None of the above seriously affects your general conclusions perhaps, but it is important at this time that we keep close to the actual facts. Mr. McCollum's study is exceedingly valuable and you have rendered a genuine service, I believe, in offering it to your readers.

PENDLETON DUDLEY.

31 Pine St., New York City, Dec. 10, 1913.

[Our figures in the editorial for the limiting weight of the London omnibuses were taken from Mr. McCullum's report; but there appears to be an error somewhere, although the total weight of the machine is much below the figures given by Mr. Dudley above. We quote as follows from Exhibit 11, accompanying Mr. McCollum's official report, being the London Police Rules issued Aug. 30, 1909, and now in force, covering the construction and use of motor omnibuses.

7. The following measurements and requirements for an omnibus with top-deck seats must be strictly adhered to, the number of passengers to be provided for on such vehicles must in no case exceed 16 inside and 18 outside.

8. Weight. Omnibuses must be so constructed that the following maxima of weight are in no case exceeded:

Unladen, 3 tons 10 cwt.

Or, if the manufacturers prefer—

Back axle weight, laden, 4 tons; front axle weight, laden, 2 tons; total weight laden not to exceed 6 tons when the vehicle is fully loaded and in every respect ready for service; 140 lb. to be allowed for each passenger as well as the driver and conductor. If the weight is not distributed in the proportion of two-thirds to bear upon the rear axle, it must be so arranged or distributed that undue weight is not thrown upon the front, nor must the maximum of 6 tons be in any case exceeded.

As the English ton is always 2240 lb., a machine weighing 6 tons, with its full complement of passengers would weigh 13,440 lb. Deducting the weight of 34 persons at 140 lb., we have 8680 lb. as the permissible maximum weight for the vehicle without its load.

Regarding the cost of the vehicles, it is, of course, true that while they are imported the cost will be excessive. The achievements of American automobile makers in the production of low-cost pleasure cars, however, give reason to expect that the cost of commercial vehicles will soon be brought down below the prices of foreign vehicles. —ED.]

Government Irrigation Work*

BY FRANKLIN K. LANE†

The Government undertook to lend itself to the development of the arid lands by what is known as the Carey Act. This was a form of coöperative effort in which the Federal Government turned over any required body of lands to a state, which the latter undertook through private enterprise to irrigate. When to irrigate meant nothing more than to divert a portion of a stream from its bed and convey it by gravity to the desert, this plan was attractive. But since these simpler methods had to be abandoned as no longer adequate, this act has done little in the promotion of such enterprise. The successful Carey Act projects are a distinguished few. Great wrongs to trustful or none-too-wise farmers were done in its name, and the suffering which it caused has made it difficult to make it serviceable, even under the more careful scrutiny of later and more cautious officials.

In 1902 Congress adopted the policy of undertaking irrigation projects of its own. The result has been the construction of some 25 projects, scattered through all of the middle-land states. In these the Government has invested approximately $76,000,000. Less than 3% of all the land which is served or which we are ready to serve is unoccupied. This work has been a success.

Soon after taking office I received a number of letters complaints I first called a conference in this city of representacomplains I first called a conference in this city of representatives from all the projects and later visited most of those from which most serious complaint had been received. My conclusion was that mistakes had been made by the service, some of which grew out of ambiguities or defects in the law, some out of inexperience, and others out of a misconception of the relationship that should exist between such a governmental service and those with whom it was dealing. A larger degree of frankness with the farmer on our part and a fuller appreciation of the responsibilities assumed on the part of the farmer will mend much of the feeling that I found.

But there is one matter of great moment to these people which should be corrected by law as soon as possible. We mistook the ability of the farmer to pay for his water rights. Ten years was the time given. His optimism and our own was too great. That time should be doubled. This should be done not alone because of the inability of many to meet their obligations to the Government, but because it will prove wise policy to give a free period within which the farmers may more fully use their farms. They can put their lands to a more profitable use, both to themselves and to the country, by being allowed to cumulate their earnings in the early years and be thus enabled to make investments in stock and machinery which will make for larger profits later.

The West can use profitably and wisely $100,000,000 in irrigation work in the next 10 years to the advantage of the whole country. Indeed, without this expenditure the asset which the Government has in its desert lands will lie unused and be of no national value.

If the Government will place upon a leasing basis the Western resources in coal, oil and minerals, it can have an increased fund for the continuance of this work and an increased assurance of the return of its advances. We should aim to make these lands of the West bring into being the latent values of the West. With a little foresight we can transform coal and oil, phosphate and timber, into green fields and electric power.

I look forward with confidence to a more intimate relationship between the states and the Federal Government in undertaking this work of developing the West. Within a few months the state government of Oregon and the Federal Government, through the Reclamation Service, have become partners in several projected irrigation plans, one involving no less than the pumping of water from the Columbia River by electric power generated by the river itself. A similar coöperative enterprise has been entered upon with the state of Washington. The plan is that we shall do the work, supplying one-half the funds and the state one-half.

One reason stands out demanding the promptest possible action in this matter. Reservoir sites are few and becoming fewer each succeeding year. Those that may be had are rising steadily in value. So valuable, indeed, have some sites become since the institution of the Reclamation Service that projected enterprises are not now regarded as feasible, for the dependent lands which it was intended to irrigate cannot make a return sufficient to pay the increased cost. And let this not be forgotten, that stored water for irrigation means also power for industries, light and heat for town and farm. These two—irrigation and hydro-electric power—are companions.

*Extract from the Annual Report to Congress.

†U. S. Secretary of the Interior.

NOTES AND QUERIES

In the paper on the Mahanoy Cable Incline on the Philadelphia & Reading R.R., published in our issue of Dec. 18, brief reference was made to the inclines on the Central R.R. of New Jersey, at Ashley, Penn., which are still used for hoisting loaded trains. These inclines were described in "Engineering News" of Mar. 25, 1909. There are three tandem inclines separated by short level stretches, and they are operated by cables and barney cars at speeds of 12 to 30 m.p.h. The total rise is 1013.75 ft. in a distance of 13,020 ft., measured on the slope.

The Operating-Control System of the Panama Canal Locks*

The immensity of the Panama Canal locks, the large number of operating machines and safety devices, compared with older canal-lock equipment, and the use of electricity as the control power, make a study of the governing equipment interesting and instructive.

As the flight of locks at Gatun, for instance, extends over approximately 6200 ft., and the principal operating machines are distributed over a distance of about 4000 ft., it can be readily seen that central mechanical transmission of control of machines would be almost impossible, and to control the machines locally would mean a large operating force distributed practically along the full length of the locks, which has invariably been the practice heretofore. Such a force would be difficult to coördinate into an efficient operating system. The situation therefore resolved itself into centralized electrical control, which reduces the number of operators, the operating expense, and the liability to accident. To secure such a system, a control board for each lock was constructed, which permitted having all control switches located thereon and mechanically interlocked so as to minimize, if not entirely to prevent, the errors of human manipulations.

GENERAL CANAL EQUIPMENT—At the Gatun Dam is a 7500-kv.-a., 2200-volt hydro-electric generating station; at Miraflores, is a 4500-kv.-a. 2200-volt steam-turbine generating plant for emergencies. A two-circuit 44,000-volt transmission line runs across the Isthmus to connect Cristobal and Balboa (where are coal-handling plants, machine shops and dry docks); there are, of course, step-down transformer stations at Cristobal and Balboa. At the Gatun, Pedro Miguel and Miraflores Locks, there are in all thirty-six 2200/240-volt transformer substations for power, light and traction service; at each of these three points there is also a 2200/220/110-volt transformer station for the lock-control boards. The scheme of connections throughout uses a double bus with duplicate oil switches so that one may be disconnected for cleaning or repair without interrupting service. In the power houses and the step-up and step-down substations the oil switches are remote-control solenoid operated; in the 36 other transformer stations in the lock walls the switches are hand operated. In these last stations are duplicate 200-kv.-a. three-phase 2200/240-volt transformers for power and a 25-kv.-a. 2200/220/110-volt transformer for lighting. These, though normally fed from the 2200-volt busses of the 4400/2200-volt substations, can be supplied from the nearest power plant—at Gatun Lock from the Gatun hydro-electric plant and at Miraflores and Pedro Miguel from the Miraflores steam plant.

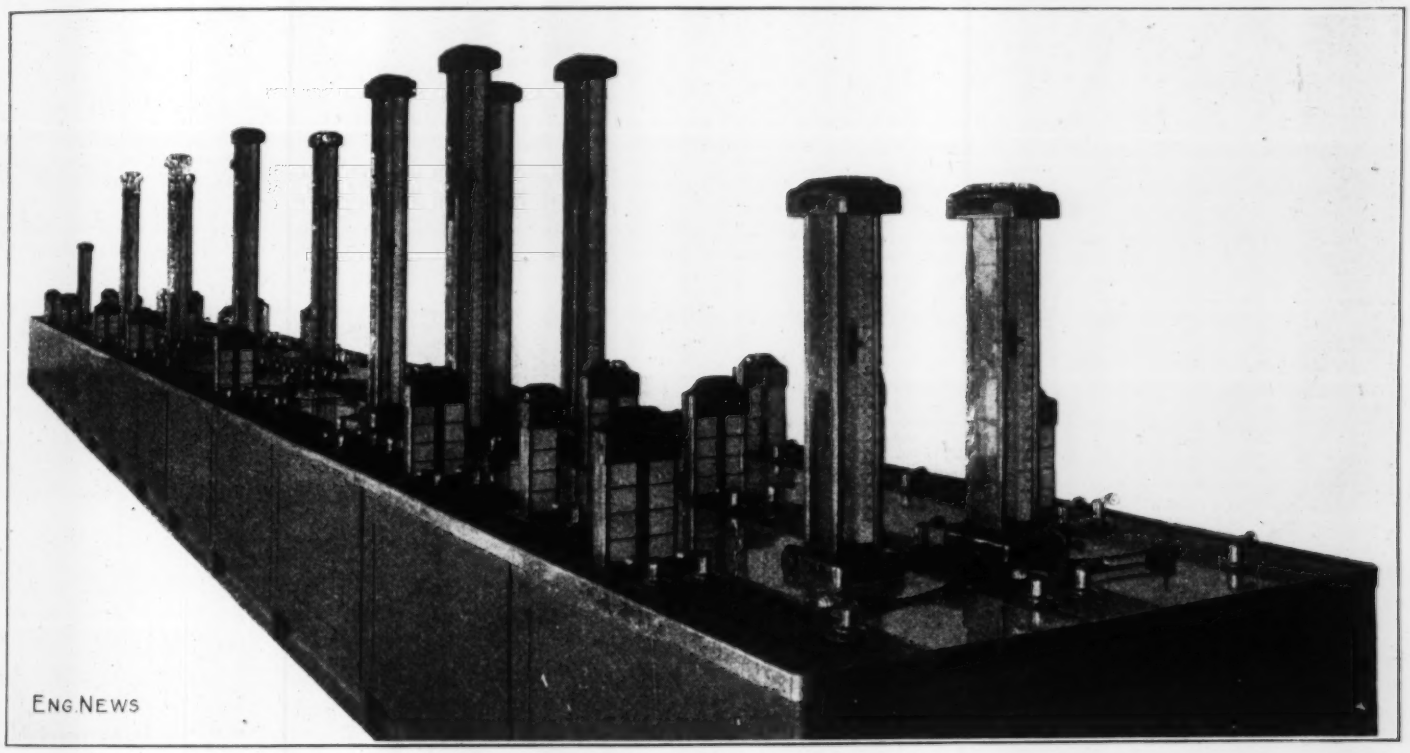


FIG. 1. ONE OF THE PANAMA LOCK-CONTROL BENCHBOARDS

While the construction and operation of the locks have been noted in ENGINEERING NEWS,* the control system is better understood by briefly noting the lock machinery. For operating advantages, the machinery was placed below the coping of lock walls, to afford a clear space for maneuvering ships and protecting the apparatus from weather without numerous houses.

A pair of lock gates is located where each change of level occurs and divides the locks into 1000-ft. chambers. In addition to these, at the lake and ocean ends are duplicate pairs used as guard gates. All these are mitering gates consisting of two massive leaves pivoted on the lock walls and operating independently. Other mitering gates divide each 1000-ft. lock into a 600- and a 400-ft. compartment. The closed gates are locked by a miter forcing machine. On the top of all mitering gates a foot walk, with hand rails, is provided. When the gates are open, these rails would interfere with the

*From information supplied by the General Electric Co., Schenectady, N. Y.

*Particularly, July 15 and Sept. 16, 1909, pp. 61 and 304; Mar. 21, 1912, p. 527; Aug. 8, Aug. 15, and Nov. 28, 1912, pp. 243, 275, 1005; May 8, 1913, p. 997.

towing locomotives and are therefore made to be raised and lowered. This is done by a motor under the foot walk, controlled (for both leaves) from either lock wall by a flush foot push. If gates are opened with the hand rails up, they will be automatically lowered and they cannot be raised when the gates are opened.

Chain fenders are stretched across the canal in front of all mitering gates which can be exposed to the upper lock level and also in front of the guard gates at the lower end. These chains are taut when the gates behind are closed, and are down while the gates are open for passage of a ship. Lowering and raising is accomplished by two motors, one driving the main pump supplying water under pressure to the cylinder mechanism and the other operating a valve which controls the direction of chain movement.

The flow in the three filling and emptying culverts (one in the middle and one in each side wall) is controlled by rising-stem valves (Stoney gates) located opposite each end of each lock.

Each culvert is divided at these valves by a vertical wall; the rising-stem valves are installed in pairs, and each pair is in duplicate. One pair of duplicates is left open as a guard. At the upper ends of side-wall culverts, are three gates in parallel, called the guard valves.

The culvert in the middle wall must serve the locks on both sides; to control this feature, ten cylindrical valves are placed on each side of the culvert at each lock in the lateral culverts that branch out on each side.

At the upper end of each set of locks, there are two auxiliary culvert valves in the side wall for regulating the height of water between the upper gate and upper guard gate, to maintain the level between at an elevation intermediate between that of the lake above and that of the upper lock where this is not at the same level.

The following table gives an idea of the number and sizes of motors to be controlled in operating the lock machinery:

Machines and operation	Motors per machine and hp.	Number of motors: Gatun	Pedro Miguel	Mira flores	Total	Total hp.
Miter gate, moving, each leaf	1-25	40	24	28	92	2300
Miter gate, miter forcing	1-7	20	12	14	46	322
Fender chain, main pump	1-70	16	16	16	48	3360
Fender chain, operating valve	1-½	16	16	16	48	24
Rising-stem gate valve	1-40	56	24	36	116	4640
Cylindrical valve	1-7	60	20	40	120	840
Guard valve	1-25	6	6	6	18	450
Auxiliary culvert valve	1-7	4	4	4	12	84
Totals		218	122	160	500	12,020

There are many motors not included, as, for instance, those for the spillway gates, hand rails and gate-leaf sump pumps.

The motors are started and controlled by contactor panels located near them handling the main currents. These contactors (two double-pole units—one for forward and one for reverse) are actuated (Fig. 6) from the central control house. The smaller motors, including those for cylindrical valves, auxiliary culvert valves and miter forcing, are started by being thrown directly on the line. In the case of larger motors for miter-gate moving, rising-stem valves and guard valves, a starting point with resistance in two legs of the three-phase circuit is provided. In all cases, these wires lead from the control boards—one for forward, one for reverse, and a common return. In the case of panels having a starting point, the period during which the motor remains on the resistance is automatically controlled by a dashpo[illegible] The control connections are arranged so that each individual machine may be controlled locally to provi[illegible] for emergency operation with the circuits from the central control house out of order.

Centralized Control and Indicating System.—The control boards are in control houses on the middle walls where is the best view of the locks, although this view is not depended on to know the position of the gates or other apparatus. The control boards are operating miniatures of the locks themselves, and are arranged with indicators which always show the position of valves, lock gates, chains and water levels in the various lock chambers; with the exception of such machinery as needs only an "open" or "closed" sign, the indicators will move synchronously with the lock machinery.

For such indication, appliances with commutators, multiple contacts or ratchet mechanism would not be suitable partly because of the many contacts and small pieces in their construction, but particularly because devices of this character move step by step and would not indicate all points in the movement of the main machinery. The indicators on the Panama control boards were developed especially for this undertaking, and show accurately and synchronously every movement of the machinery to which they are connected, whether in the extremes of travel or at any intermediate point.

A complete synchronous indicator consists of (1) a transmitter located at, and operated by, the machine in the lock wall, and (2) a receiver operating an indicator at the central switchboard. Both transmitter and receiver have a stationary and a rotating part. The stators have three-phase windings (Fig. 6) with leads from three corresponding equidistant points brought out and connected together, but not connected to a source of power, the stator coils being energized by induction from the rotors. The rotors are bipolar and are connected in multiple and energized from a 110-volt 25-cycle single-phase source.

The movement of the lock machinery, and with it the connected transmitter rotor, produces a field in the transmitter stator polarized in the direction of the rotor axis, which induces voltage in the stator coils. This voltage is transmitted by the three-phase connection above mentioned to the receiver stator coils and duplicated in them, but in the reverse direction, the same conditions of polarity and voltage as present in the transmitter. The rotor of the receiver being energized by the external source in the same direction as that of the transmitter, is reacted upon by the polarized receiver stator until the magnetic axes coincide and the rotors of both transmitter and receiver are in the same relative position. Any difference in the position of the transmitter and receiver rotors causes a difference of potential between the stator windings with a consequent flow of current and resultant torque, which again moves the receiver rotor to the same relative position as that of the transmitter rotor. The receiver rotor follows closely and smoothly the movement of the transmitter rotor, and consequently imparts to the position indicator a movement identical with the movement of the lock machine, although on a scale reduced to the requirements of the control board.

The vertical operating shaft of the mitering gates is connected to a shaft which operates the transmitter ro-

chine. The latter shaft is threaded and carries a nut and rack. The rack engages a gear on the transmitter rotor shaft which turns as the gates operate. The mitering gate indicator (Fig. 5) comprises a pair of aluminum bars (shaped to correspond to the plan view of the top of the gate) which swing horizontally close to the bench, the hinge ends being connected to shafts extending down through the surface of the board where they are bevel geared to the receivers.

For the chain fender, the transmitter is driven by a shaft which operates the limit switch controlling the stroke of the operating piston. The indication on the board is given by a small aluminum chain, which, like the large chain, is raised and lowered, each end operating independently. The ends of the miniature chain are fastened to semaphore arms which are connected to segmental gears meshing with the driving gears on the receiver machines. As the receiver rotors turn, the chain is either lifted or lowered, the position of the large chain from the bottom of the lock being indicated by the angle of the semaphore arms.

As the rising-stem valves occur in pairs, their position indicators occur in pairs also. The transmitter rotor is driven by a shaft and gearing similar to that of the mitering gates. Each indicator (Fig. 5) is a tiny elevator. Both front and back of the shaft is fitted with opal glass marked with black lines for the ¼, ½ and ¾ positions. A small aluminum cage moves up and down in each compartment to indicate the position of the gate. A drum for operating the cord which raises and lowers the cage is located underneath the control board and is operated by the receiver through a suitable train of gears. To make the indications visible from points up and down the control board, the elevator shaft under each car is always illuminated and the portion above is dark.

The specifications covering the water-level indication required an accuracy of $\frac{1}{20}$ ft. or $\frac{1}{10}$ of 1% in actual water level. In the transmitters and receivers for the machines described previously, the rotors turn less than 180° with an inherent lag of 1½% between transmitter and receiver rotors in this distance, which obviously prevents the arrangement from being employed to give the water-level indication.

It was found that if the rotors made ten complete revolutions, the required accuracy could be obtained; but since this arrangement makes it possible for the rotors to be in synchronism every 180°, or in 20 different positions for the entire travel, the indicators would not indicate correctly if for any reason the transmitter rotors should be turned more than half a revolution with the power off. Therefore, the required accuracy was obtained by two sets of transmitters and receivers, one set connected to a fine index in which the rotors make ten complete revolutions and the other set connected to a coarse index and moving less than 180°.

The fine index is a hollow cylinder carrying a pointer, the length of the cylinder being such that when an aluminum ball representing the coarse index, which can be depended upon for coarse indication, is within the limits of the cylinder, the reading of the fine index is correct within the limits specified. The scales are illuminated by lamps in both base and top caps of the indicator.

For water-level indication, 36-in. square wells in the lock walls with communication to the lock by an opening at the bottom of each well, made small to dampen surges, contain welded-steel box floats 30 in. square by 9 in. deep. A non-slipping phosphor bronze belt transmits the movement of the float to a sheave fitted with pins on the transmitter mechanism, the pins registering

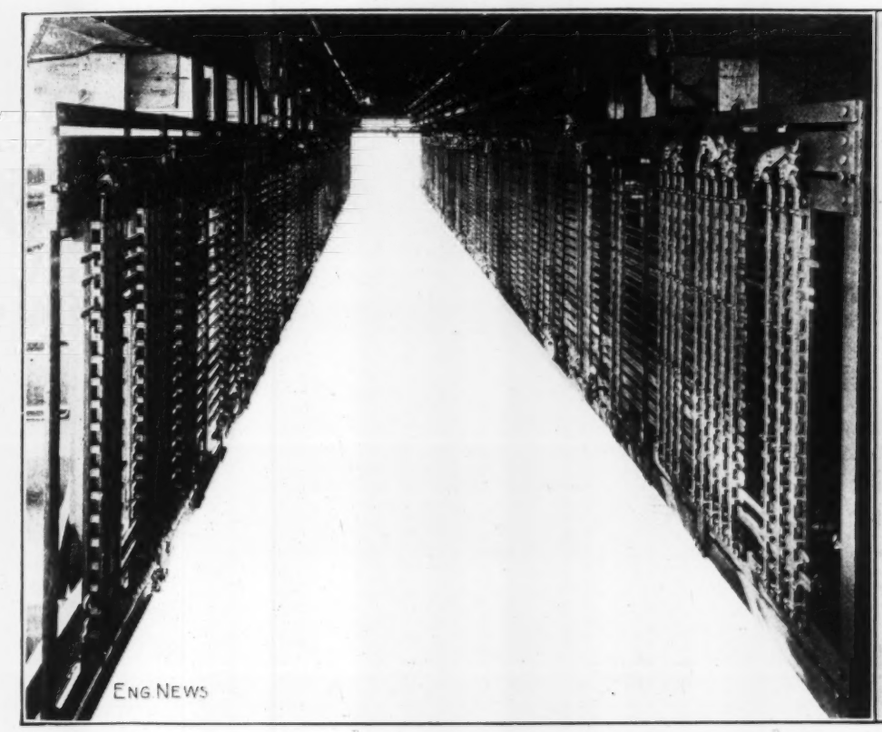


FIG. 2. MECHANICAL INTERLOCKING BENEATH LOCK-CONTROL BOARD

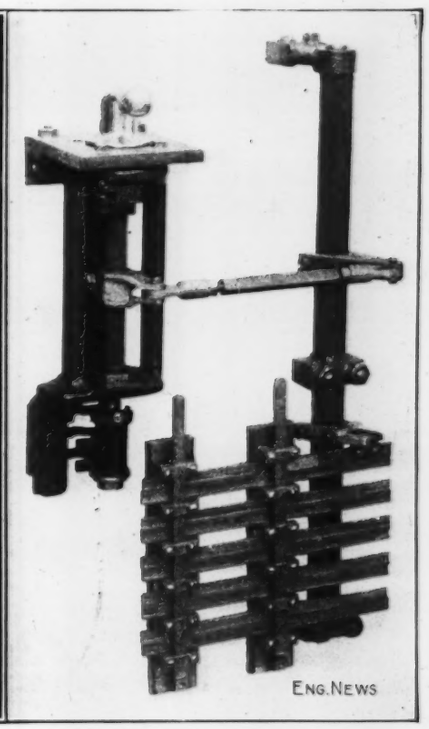


FIG. 3. TYPICAL CONTROL SWITCH AND INTERLOCK MECHANISM

with holes punched in the belt. The sheave shaft is carried in ball bearings with oil cups for lubrication and drainage cocks at the bottom of the bearings.

The position of the miter forcing machine is not indicated by synchronous indicators, but its open and closed positions are shown by red and green lights and a mechanical indicator on the control board representing the machine.

The control boards are of flat-top benchboard type, 32 in. high by 54 in. wide, built in sections. The total surface of the board and operates through an angle of 90°. They are provided with nameplates for "open," "closed" and "off" positions. The space immediately below the flat top of the control board (Fig. 2) is occupied by the contact fingers of the control switches mounted on the operating shaft, the synchronous receivers and their cable connections. Connection boards are provided for the cables, which are led up from each side, as are the buses for supplying current to control switches, receivers and scale lamps.

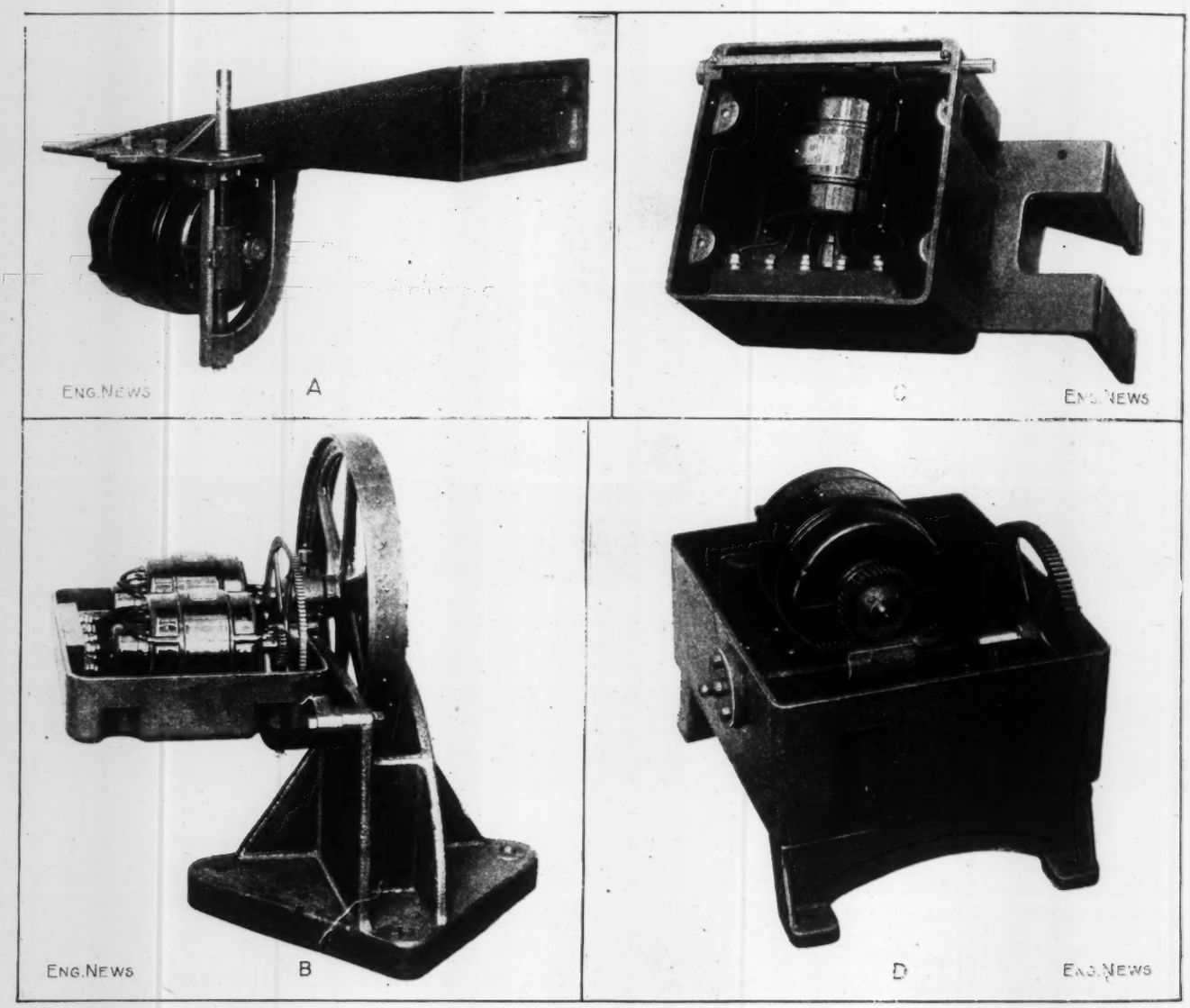


FIG. 4. TRANSMITTERS OF INDICATOR SYSTEM
(A, miter gate; B, floatwell; C, chain fenders; D, Stoney gate.)

lengths were: for Gatun, 64 ft.; for Pedro Miguel, 36 ft.; for Miraflores, 52 ft.

Side and center lock walls are represented by cast-iron plates and the water by blue marble slabs. The outer edge of the board is surrounded by a brass trim rail, and the sides are inclosed with steel plates which can be readily removed for inspection of the board. The control board is supported by a wrought-iron framework resting on base castings, which are in turn supported on the operating floor of the control house.

The control switch handles are mounted above the

MECHANICAL INTERLOCKING SYSTEM—In order to make it necessary for the operator to throw the control switch handles always in a certain order, corresponding to a predetermined sequence of operation of the lock machinery, and to prevent the operator in control of one channel from interfering with the machinery under the jurisdiction of the operator controlling the other channel, these control switches are provided with interlocks. The interlocks are in two vertical racks under each edge of the board and some distance below (Fig. 2), so that they may be inspected and oiled from a floor which

about 7 ft. below the floor on which the switchboard operator stands. The latter floor does not extend across under the board, this space being open so that all parts on the under side of the board are accessible from the floor below.

Vertical shafts operated by connecting-rods from the control switch shafts extend downward past the electrical parts for the operation of the interlocks. The interlock system (Fig. 3) is essentially a bell-crank mechanism, connecting the shaft of the control switch through a movable horizontal bar to a vertical operating shaft which can or cannot move according to the relative positions of the interlocking bars and dogs. The interlocking rack is a steel frame carrying five horizontal members. Upon these and tying them together are vertical steel straps which carry brass runway posts for the vertical and horizontal interlock bars. These posts are riveted to the vertical steel straps, a thin brass plate between posts and straps making the runways non-corrosive. The vertical operating shafts are of square steel turned on the ends and work in brass bearings near the top and bottom of the interlocking rack. Forked cranks mounted on the vertical operating shafts move the horizontal interlock bars by means of pivot blocks set over pin blocks riveted to the horizontal bar. The interlock bars and dogs are of special-shape hard extruded brass, which section keeps the dogs in line with the axis of the bars when under pressure by being engaged with another dog on a vertical bar. Every control switch uses a horizontal bar of from 3 to 50 ft. long.

The interlock system depends mainly on the action of engaging bevel dogs located on horizontal and vertical bars, the movement of a horizontal bar tending to lift a vertical bar by bevels on the dogs. A horizontal bar cannot be moved without raising a vertical bar. Thus, if at any time a dog on a horizontal bar rests against the upper end of a dog on a vertical bar, no movement of the horizontal bar where the dog engages with the vertical bar can take place, and the control handle connected to that particular horizontal bar is locked.

Interlocks prevent the chain fender from being lowered until adjacent mitering gates have been opened, and also prevent the gates being opened until the chain is in the raised position. In this way it is assured that the chain fender will always be in the up position to protect the gate when closed. To avoid unnecessary complication, each end of the chain is interlocked with the leaf on its side of the lock only, because as a rule both leaves of a gate, as well as both ends of a fender chain, will be opened simultaneously, and further interlocking is unnecessary. After the mitering gates are closed, a miter forcing machine is operated by a control handle and locks the ends of the gates closed. This machine cannot be operated until the gates are closed.

Also the rising-stem gates of the side wall, next above or below a miter gate, must be closed while the miter forcing machine is open. As the miter forcing machine cannot be closed until the gates are closed, this means that the valves either above or below the gate must remain closed until the gate itself is closed, thus preventing the operator from creating a current of water around the gates while they are open, or being moved in opening or closing. This interlock is not included on the middle wall valves for the reason that they will be used with the locks on either side and must be free from that purpose.

Either pair of rising-stem valves may be opened first, at the choice of the operator, an interlock becoming effective when the first valve of the second pair of duplicates is opened. This is done by a novel arrangement of equalizing levers acting against the ends of the interlock bars, with certain definite amount of lost motion which is taken up on opening the first pair of valves, thus putting the interlocks in operation on the next pair. To illustrate this operation, consider for example a side-wall culvert at Gatun with its principal rising-stem valves at

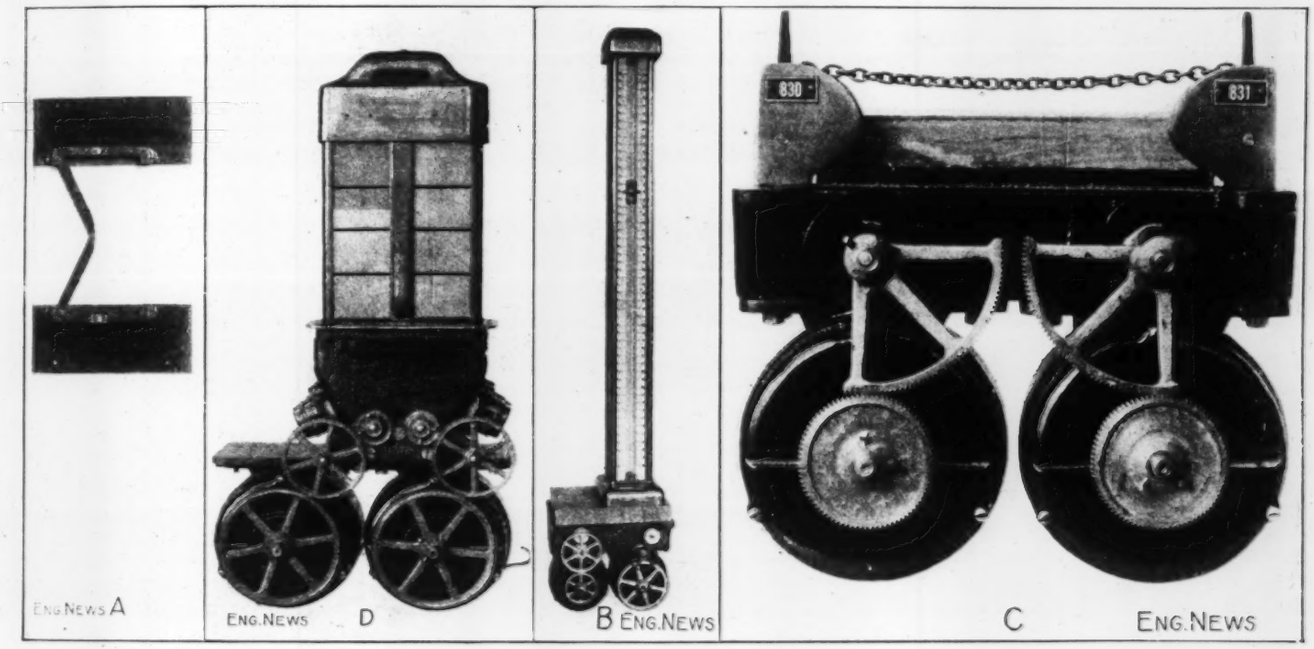


FIG. 5. RECEIVERS AND INDEXES

(A, miter gate; B, floatwell; C, chain fenders; D, Stoney gate.)

each change of level from one lock to the next. The control of these valves is interlocked so that if the valves are opened at one particular point, the valves a lock length upstream or downstream cannot be opened. Thus the operator is limited to equalizing the water between locks and cannot allow water to flow from the upper lock past the middle lock into the lower lock which operation, if permitted, might flood the lower lock walls and the machinery chambers in them. The cylindrical valves are interlocked so that if those on one side are opened the ones on the other side are locked closed, and the opening of one switch on a side will lock the opposite ten. This prevents careless cross-filling between locks, which operation might be combined with the regular method and produce flooding. However, there may be times when it is desirable to employ cross-filling to economize in the use of water from Lake Gatun in the dry season. For

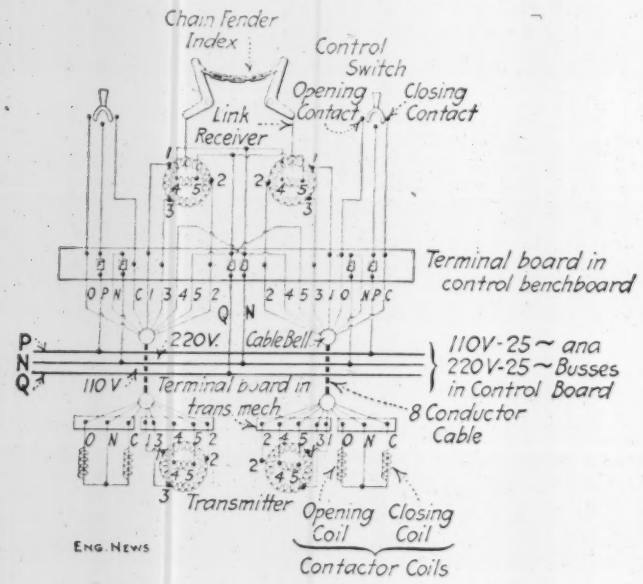


FIG. 6. DIAGRAM OF INDICATOR SYSTEM, PANAMA CANAL LOCK CONTROL

this reason this interlock is made removable by the use of a Yale lock and key. The key will be placed in the hands of the chief operator.

In the use of the middle-wall culvert, the cylindrical valves on one side or the other must be opened before the rising-stem valves can be opened, and the rising-stem valves must be closed first. This interlock is applied in order to require the operator to control the flow of water by means of the rising-stem valves rather than by the cylindrical valves.

In most cases the locks are divided into two unequal parts by the intermediate mitering gates. This arrangement makes it necessary to divide the ten cylindrical valves into two groups of seven and three, respectively, for the long and short lengths. A selecting lever is provided for these interlocks and may be set as indicated by a nameplate on the lever to "three," "seven" or "ten," respectively; whereupon the corresponding valves are subject to that interlock, and the others of the group of ten are locked closed if three or seven only are to be used. The failure of the operator to make his selection properly in advance will simply cause him the trouble of going back and doing so, as the remaining valves are locked closed. This arrangement permits handling small vessels without causing waste of water due to operating such vessels in the large chambers. If a short vessel were being passed downstream, it would first pass into the chamber having three cylindrical valves. The group selective lever would then be placed on the "three" position which would permit the opening of three valves above the intermediate gate, but would lock closed the other seven valves above it. After the vessel has been passed below the gate the handle may be reversed, releasing the lever and locking three switches.

There are intermediate rising-stem valves in the side walls at each intermediate gate, but no interlocks are applied to these for the reason that they will be used in a more or less irregular manner, and no fixed laws for their operation can be made in advance. Moreover, they control the water only between different sections of the same lock, and there is not the danger from mistakes in operation which exists in the case of the other valves which control water between lock levels. The same is true of the small auxiliary culvert valves, by means of which the space between the upper guard gate and upper main gate is filled and emptied.

In case a large vessel is to be locked through, the interlocks on the intermediate gates can be made ineffective by the operation of a Yale lock which uncouples a clutch and disconnects the central switch from the operating mechanism. Turning the key removes the interlock and permits the intermediate gates to be thrown open to obtain a 1000-ft. level and the valves operated independently of these gates.

To obviate the possibility of flooding the locks when valves are in a certain position, diagonal interlocking is introduced between the rising-stem gates of the side wall and those of the middle wall a lock length away. This interlocking between valves diagonally across a lock when the cylindrical valves are open is needed to prevent the flow of water from, say, the upper lock by way of a side-wall culvert to the middle lock, thence by way of the middle-wall culvert to the lower lock. If the cylindrical valves of a certain lock are closed, the interlock is not needed on the rising-stem valves of that lock; and since such interlock would interfere with the proper use of the valves of its twin lock on the other side of the middle wall, this interlock is automatically removed when all ten cylindrical valves are closed on the particular lock in question, and is automatically applied again if one or more of the ten cylindrical valves are opened. Furthermore, the valves of the side wall immediately at the gate which is being moved will be open to equalize water level, and diagonal interlocking will prevent the opening of the middle-wall valves a lock length above or below the gate being moved. Each of the four valves of such a group has independent control, their control switches being so interlocked that either pair may be opened and left open as guard valves, the interlocks becoming effective when the operator tries to open the first valve of the second pair. In addition to these pairs of valves in parallel, each pair is duplicated at each change of level from one lock to the next.

SPECIAL CLIMATIC REQUIREMENTS—To withstand the humid atmosphere of the Isthmus, every possible insulation was impregnated with non-hygroscopic compounds. All small parts were made either of brass, copper, Monel metal, bronze, or of sherardized iron or steel. Mica and treated asbestos lumber were used largely in place of fiber or wood.

DESIGN, MANUFACTURE, ETC.—The specifications for the entire generating, lock-controlling and distribution system for operating the Panama Canal were prepared under the supervision of Edward Schildhauer, Elec-

and Mechanical Engineer, Isthmian Canal Commission, assisted by a staff, including C. B. Larzelere, who was closely identified with the lock-control problems, and W. R. McCann with the generation and distribution of power. These specifications contained every safeguard that could be suggested, were exact and explicit in regard to the results required, yet gave wide range to manufacturers in the details of accomplishment.

All the motors, control equipment, power station and substation apparatus, and practically all the electrical equipment of the coaling stations, wharf terminals and repair shops were made by the General Electric Co., of Schenectady, N. Y. The entire job was planned for regular manufacturing practice, thus making spare parts more available. Some 2000 special drawings were required. There were used the following unusual amounts of materials.

Special slate bases	1,300
Small castings	160,000
Screw-machine parts	1,200,000
Copper rod and bar, lin.ft.	58,000
Asbestos lumber, sq.ft.	9,000
New patterns	650
New jigs, templates, tools, etc.	625
Porcelain parts	18,000
Special bus supports	6,800
Gal. pipe (framework), lin.ft.	21,000
Special gears	2,300
Special instruments	640
Miscellaneous sherardized pieces	300,000
Cases for boxing	4,150
Five and eight conductor leads, lin.ft.	6,000,000
Indicator motors	732
Control switches	464
Combined weight of three boards, tons	39

Notes on the Construction of the St. Louis Filters

By Edward E. Wall*

The contract for the concrete sub-structure, filter-boxes, influent and effluent conduits and connections of the St. Louis filter plant was awarded to the McCormack-Combs Construction Co., of St. Louis, on Apr. 18, 1913, for the sum of $225,023.* The location of these filters in the western portion of an existing sedimentation basin (No. 7) as shown in Figs. 1 and 2, avoided any necessity for excavation, and made it possible for the contractor to design a comparatively simple plant for mixing and placing concrete. The ground elevation on the west side of Basin No. 7, being 23 ft. above the basin floor, permitted the laying of a switch track along the west basin wall, so that material could be dumped from cars at the mixer. At the mixer the track was elevated 4 ft. above the wall coping, and the mixer placed in a pit 22 ft. deep, over which two bins were built to contain gravel and sand. The gravel bin holds about 14 cars and is 40x40x12 ft. deep, and the sand bin is 29x30x 12 ft. deep, holding about 10 cars. A cement shed was built adjacent to these bins, for the storage of 1500 bbl. of cement.

A concrete mixer with a single batch capacity of 22 cu.ft. was installed in the pit, in such a position that it discharged into the skip operated in a tower 119 ft. high. This tower is the highest one shown in Fig. 2. From this tower main chutes run for the entire length of the filters, approximately 700 ft. Concrete may be taken from the main chutes at any one of the twelve towers and carried to any point of the work. The grade of the main chutes is 20%. The movable chutes are made of steel, U-shaped, in one piece, 12 in. wide and 10 in. deep. The main chutes are 12x12 in., made of wood, lined with sheet iron, spanning 45 ft. between towers.

The velocity with which the concrete flows from the main tower to its destination is about 480 ft. per minute. In placing concrete 400 ft. from the main tower, the average time per batch of concrete is 2½ minutes.

The concrete used in the groined inverted arches, columns, outside walls and floor under filter-boxes is com-

*Water Commissioner, St. Louis, Mo.

*An article by Mr. Wall, describing this new filter plant, appeared in our issue of Oct. 23, 1913.—Ed.

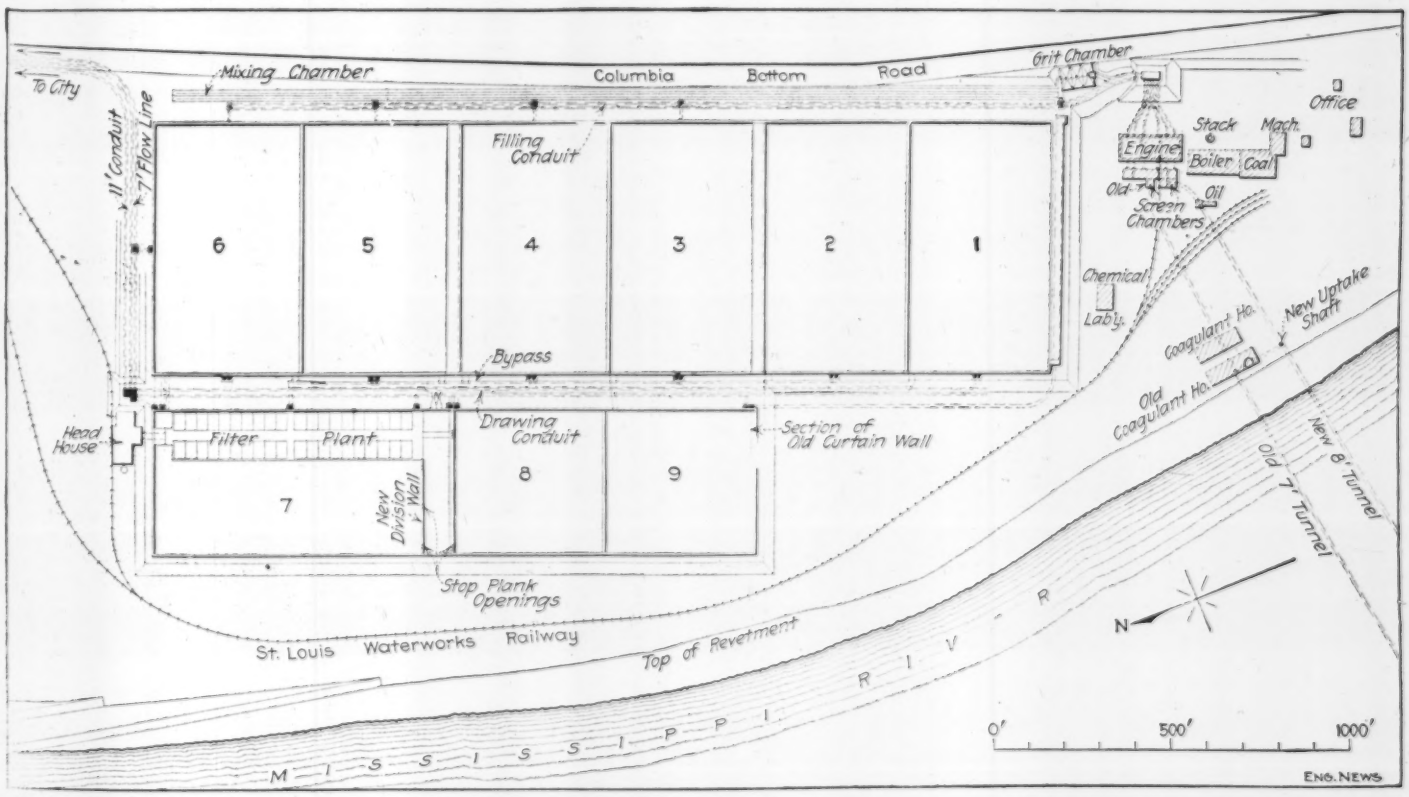


Fig. 1. General Plan of New Water Filtration Plant at St. Louis, Showing Location in One of the Old Sedimentation Basins

(Reproduced from "Engineering News" of Oct. 23, 1913.)

posed of 1 part cement to 5½ parts sand and gravel, while that in filter boxes, operating floor, conduits and connections, is 1 part cement to 4½ parts sand and gravel.

Twenty-five pounds of hydrated lime per barrel of cement is added to the concrete for the filter-boxes and influent conduit to make it water-tight. This concrete is mixed one minute in the mixer, 25 seconds elapses while discharging into skip and from 20 to 50 seconds as it flows through the chutes. This gives a very uniform and thorough mixture at the point of delivery.

The forms for all arches are made of wood covered with 26-in. gage galvanized iron, each arch being formed of four parts resting on four columns. Columns and arches are formed at the same pouring, the galvanized iron being coated with paraffin each time the forms are set up.

Ties for holding the wall forms are made of loops of No. 10 gage strap iron, 1¼ in. wide, the ends riveted together, ½-in. holes punched in the ends of the loop to allow square-headed bolts projecting from the outside of the forms to be tightened up by turning from the outside through the nuts held in the loop. In removing the forms, the bolts are unscrewed from the nuts, leaving the loop in the wall at least 2 in. from the surface. The loop, nuts and bolts are shown by Fig. 3.

In pouring concrete the end of each day's work is blocked off, leaving grooves wherever practicable, in order to secure a good bond at the junction. Where grooves cannot be left, corrugated sheet steel is embedded about 6 in. in the concrete, leaving a like width to extend into the concrete placed later.

FIG. 2. CONSTRUCTING THE NEW MECHANICAL WATER FILTERS FOR ST. LOUIS, MO., IN A PORTION OF ONE OF THE OLD SEDIMENTATION BASINS

FIG. 3. TIES FOR HOLDING WALL FORMS USED IN CONSTRUCTING ST. LOUIS WATER FILTERS

Each filter-box, containing 107 cu.yd. of concrete, is poured as a monolith and must be completed in one pouring, requiring between five and six hours to complete the box.

The mixing and placing of concrete was begun July 17, 1913, and up to Dec. 13, 1913, 12,688 cu.yd. had been poured. This includes the entire substructure below the filter-boxes, the effluent conduit and 38 filter-boxes. In 27 working days from Nov. 12 to Dec. 13, 24 filter-boxes were poured.

The cost of forms for the filter-boxes was as follows:

	Per cu.yd.
Fabricating	$0.14
Erecting	1.96
Stripping and moving	0.86
Foreman	0.11
Total	$3.07

This is about 7c. per sq.ft.

Castings connecting with the underdrain piping are set in the floors of the filter-boxes before pouring. The underdrain piping is put together and the joints leaded, when the entire piping for one side of each filter is hoisted into place, bolted to the floor castings and securely held in place by stirrups, the ends of which are threaded into castings imbedded in the concrete. Turnbuckles are placed on the stirrup legs, so that the piping may be adjusted to its exact position.

The cost of erecting form work for columns, walls and arches was $1.65 per cu.yd. of concrete, or $0.055 per sq.ft. of developed surface. Erecting the form work for the effluent conduit cost $1.55 per cu.yd. of concrete, or $0.04 per sq.ft. of surface.

NOTES FROM THE ENGINEERING SCHOOLS

OHIO STATE UNIVERSITY—The state legislature at its last session appropriated funds for a winter course in highway engineering which was started a year ago, as noted in ENGINEERING NEWS, Feb. 27, 1913. The course this year will be given from Feb. 16 to Feb. 28, 1914, and is arranged particularly for city and county engineers, commissioners, contractors and inspectors.

IOWA STATE COLLEGE—The first annual short course for road builders will be given from Dec. 29, 1913, to Jan. 7, 1914, at Ames. It is not intended to make highway engineers in this period but to assist to a better knowledge of construction and administration methods. The specialists gathered will, in addition to lecturing, give conferences with engineers on specific problems. There will be evening lectures of more general interest, open to the public.

CASE SCHOOL OF APPLIED SCIENCE—From Jan. 19 to 31, 1914, the Department of Civil Engineering will offer a course in Highway Construction, at Cleveland, for engineers, contractors, inspectors, prospective applicants for positions in the state highway service and any others interested.

There will be forenoon lectures on highway economies, types of roadways and construction and maintenance; afternoon lectures and laboratory work will cover materials of construction (cement, concrete, paving brick, crushed stone, etc.). There will be conferences for the discussion of costs and methods of construction and maintenance. Special additional lectures will be given on culverts and bridges.

This instruction will be in charge of Maurice B. Greenough, Instructor in Civil Engineering, to whom inquiries for further information should be addressed. Some of the special lectures will be by James R. Marker, State Highway Commissioner, and other specialists. The course has the coöperation of the State Highway Commission. There are no entrance requirements and no fees to be paid for the course.

NOTES

A Further Step Toward Municipal Ownership of Water-Works at San Francisco, was taken on Dec. 8, when the Board of Supervisors passed an ordinance declaring that public necessity requires the purchase by the city of some of the property of the Spring Valley Water Co. The ordinance directs the city attorney to take steps to acquire the works by a condemnation suit.

Claims Against the Husted Milling Co., of Buffalo, N. Y., following the disastrous dust explosion on June 24, will be settled by the payment by the company of $93,000. The death claims number 33 and the injured 63. The plan was approved in the surrogate's court on Dec. 16, and Judge Haight was named as referee to determine how the money shall be apportioned among the claimants. Judge Noonan previously decided that it was impossible, from the evidence, to determine the cause of the explosion ("Eng. News," Aug. 21, p. 386). The details of the accident are given in "Engineering News," July 3, p. 47, July 10, p. 88, July 31, p. 223.

Direct Current at 2400 volts will be used on the electric traction system of the Chicago, Milwaukee & St. Paul Ry., between Three Forks and Deer Lodge, Mont., 113 miles. The general plans for replacing steam by electricity over 450 miles, of which this is a central section, were noted in "Engineering News," Jan. 16, 1913, p. 132. A connecting line, the Butte, Anaconda & Pacific Ry., has operated for several months with direct current at 2400 volts as described in our issue, of Aug. 15, 1912, and June 26, 1913.

The Canadian Pacific Ry. will use direct current at 2400 volts on 30 miles of route (43 track miles), near Rossland, B. C., in the Canadian Rockies. The grade here is 4% and four locomotives will be used.

The Pennsylvania R.R. will use single-phase current at 11,000 volts for the suburban lines out of Philadelphia, conversion of which from steam was noted in "Engineering News," Apr. 3, and Oct. 9, 1913, pp. 656 and 733.
M.N. Soc. PROC.

Tests of the Direct-Acting Explosion Pumps (Humphrey design), at Chingford, England, described in "Engineering News," Apr. 17, 1913, have been reported by W. B. Bryan, Chief Engineer of the Metropolitan Water Board, London. The capacity trials showed an average rate of 47.5 million gallons per day (compared with a guarantee of 40 million); the small pump raised at the rate of 26.1 million gallons (compared with 20 million guaranteed). The average fuel consumption of the large units was 0.931 lb. anthracite per water horsepower-hour (compared with 1.1 lb. guaranteed); the small unit showed 0.8 lb. These figures do not include coal used in raising steam for gas making, which was approximately 15% of the amount of anthracite used. In making the fuel-consumption tests, first the yield and calorific value of gas from the producers were determined and then the gas consumption of the engines. The producers were specified to yield 78 cu.ft. of 150 B.t.u. gas per lb. of anthracite; it is reported that the figure "was exceeded." The endurance trials were delayed on account of low water in the River Lea, but they have since been carried out "with entire satisfaction."

A Spokane River Bridge is to be built by the Oregon-Washington R.R. & Navigation Co. across Spokane Falls, in the city of Spokane, Wash. The river here makes a short turn just below the falls, and the railway bridge is located so that it passes, almost at right angles and at a roadway elevation some 40 ft. higher, over the Monroe Street bridge, a large concrete structure built some years ago by the city. The Monroe Street bridge, with its middle arch of 281-ft. span, is a monumental concrete structure of exceptional artistic value, and there was some discussion in the local press urging that the railway be required to erect a bridge of at least equal artistic merit; but after detailed comparisons had been made by the railway authorities, as between steel and concrete arches and steel viaducts, and after due attention had been given to aesthetic considerations, permanence and costs, a steel viaduct was chosen by the railway and approved by the City Council.

The new bridge is to be about 830 ft. long, and comprises one 160-ft. and one 195-ft. truss span, one 110-ft. plate-girder span and three shorter plate-girder spans, all resting on structural steel towers, with the exception of one tower under a short plate-girder span and the shorter truss, which is a masonry tower. It is to be a two-track, ballasted deck structure.

It is stated that the most serious objection to a large

masonry arch bridge was the lack of adequate foundation. One side of the river is bed rock on the surface; the other has loose gravel and sand to a depth of 90 ft., the greater portion of which is under water. This requires at least a 160-ft. span and a high abutment similar to that on the Monroe Street bridge, and the cost of such construction, as well as the possible danger in erection was considered prohibitory by the railway.

The Results of the Civil Service Examinations for mechanical and electrical engineering positions under the Interstate Railway Valuation Board are tabulated below. Our issues of Nov. 13 and Dec. 4 contain all the results made public previous to this list. There still remain the positions of Inspector of Car Equipment, Inspector of Motive Power, Railway Signal Engineer, Senior Architect, Architect, and Examiner of Accounts, the results of the examinations for which have not been announced.

SENIOR MECHANICAL ENGINEER

	91 and over	81 to 90	70 to 80
District I.			
First grade	.....	10	1
Second grade	.....	7	4
District II.			
First grade	1	4	1
Second grade	..	..	..
District III.			
First grade	..	4	..
Second grade	..	1	1
District IV.			
First grade	2	2	4
Second grade	..	2	1
District V.			
First grade	..	..	3
Second grade	..	1	..
Totals	3	31	15
Grand total	49		

ELECTRICAL ENGINEER

District I	..	6	7
District II	..	..	1
District III	..	2	1
District IV	..	1	3
District V	..	1	6
Totals	..	10	18
Grand total	28		

SENIOR INSPECTOR OF CAR EQUIPMENT

District I	1	11	4
District II	..	4	6
District III	1	5	2
District IV	1	6	7
District V	1	7	2
Totals	4	33	21
Grand total	58		

SENIOR INSPECTOR OF MOTIVE POWER

District I	4	28	55
District II	3	27	26
District III	4	16	40
District IV	3	9	29
District V	1	10	26
Totals	15	90	176
Grand total	281		

PERSONALS

Mr. J. E. Ballenger has been appointed County Engineer of Duval County, Fla., with headquarters at Jacksonville, Fla.

Mr. Lee S. Trainor, of Centralia, Ill., has been appointed Superintendent of Highways of Marion County, Ill., under the new Illinois highway law.

Mr. W. M. Whitenton, General Manager of the lines east of the Missouri River of the Chicago, Rock Island & Pacific Ry., has resigned, effective Jan. 1.

Mr. James Allen, of Olympia, Wash., has been appointed Chief Engineer of the State Highway Department of Washington, succeeding Mr. Will R. White.

Mr. W. E. Earl, Chief Engineer of the California Railroad Commission, has resigned, effective Jan. 1. Mr. H. J. Bermier, Assistant Engineer, has also resigned.

Mr. James G. Heaslet, Chief Engineer of the Studebaker Corporation, South Bend, Ind., has been elected Vice-President in charge of engineering and production.

Mr. F. B. Marble has been appointed Division Engineer of the Michigan Central R.R., with headquarters at Niles, Mich., succeeding Mr. C. C. Hill, promoted, as noted elsewhere.

Mr. Henry M. Leland, M. Am. Soc. M. E., General Manager of the Cadillac Motor Car Co., Detroit, Mich., has been nominated for President of the Society of Automobile Engineers.

Mr. E. P. Weatherley, M. Am. Soc. C. E., Division Engineer of the Kansas City Terminal Ry., has been appointed Engineer of Maintenance-of-way, with headquarters at K City, Mo.

Mr. C. C. Hill, District Engineer of the Michigan Ce R.R., at Niles, Mich., has been promoted to be Constru Engineer, succeeding Mr. J. F. Deimling, promoted, as elsewhere.

Mr. W. W. Ewing, M. Am. Soc. C. E., formerly Engi Westinghouse, Church, Kerr & Co., has accepted a pos in the construction department of the Thompson-Starrett 51 Wall St., New York City.

Mr. A. H. Nelson, Assoc. M. Am. Soc. C. E., formerly M ager for the Nelson-Merydith Co., Chambersburg, Penn. s been appointed County Engineer of Atlantic County, N. J at a salary of $5000 per annum.

Mr. Frank C. Greene, Geologist of the Missouri Geological Survey, was married Dec. 18, to Miss Eva Endurance Hu a graduate mining engineer and also a member of the staff of the Missouri Geological Survey.

Mr. Norman M. Crawford, Assoc. Am. Inst. E. E., of Youngstown, Ohio, formerly President of the Mahoning & Shenango Ry. & Light Co., has been elected President of the Reading Transit & Light Co., Reading, Penn.

Mr. E. H. Ziegler, recently Superintendent of Terminals of the Cleveland, Cincinnati, Chicago & St. Louis Ry., has been appointed Superintendent of the Peoria & Eastern Ry., at Indianapolis, Ind., succeeding Mr. B. C. Byers, transferred.

Mr. M. Tschurgi, of Cedar Rapids, Iowa, has been appointed City Engineer of Monticello, Iowa, to take charge of much new paving work. Mr. Tschurgi served the city in the same capacity during the installation of the sewerage system.

Mr. T. T. Richards has been appointed Assistant Sales Manager of the Wagner Electric Co., St. Louis, Mo., not Sales Manager as stated in our personal columns of last week. The Sales Manager is Frank N. Jewett, Assoc. Am. Inst. E. E.

Mr. George F. Wieghardt, recently Assistant Engineer on the design of the Lake Montebello filtration plant of the Baltimore (Md.) water-works, has been appointed Assistant to the Chief Engineer of the Pennsylvania State Dam Commission.

Mr. J. M. Davis, General Superintendent of the Central division of the Southern Pacific Ry., at San Francisco, Calif., has resigned, effective Jan. 1, 1914, to accept a position with an Eastern railway, the name of which has not yet been announced.

Mr. C. F. Burrell has been appointed Engineer and Roadmaster of the Kentucky & Indiana Terminal R.R., with headquarters at Louisville, Ky., succeeding Mr. J. B. Wilson, Assoc. M. Am. Soc. C. E., Engineer, and Mr. J. J. McKenzie, Roadmaster, resigned.

Mr. W. Thomas Wooley, City Engineer and Architect, of Schenectady, N. Y., formerly City Engineer of Auburn, N. Y., and later Engineer of the Public Improvement Commission of Hoosick Falls, N. Y., has been appointed City Engineer of Syracuse, N. Y., by Mayor-elect Louis Will.

Mr. George J. Siedler has resigned as Sales Manager of the Taylor-Wharton Iron & Steel Co., High Bridge, N. J., to become Vice-President of the Eynon-Evans Manufacturing Co., of Philadelphia, Penn. He is succeeded as Sales Manager of the Taylor-Wharton Iron & Steel Co. by W. S. Stothoff.

Mr. A. C. Toner, Assoc. M. Am. Soc. C. E., will resign as Assistant Engineer, Baltimore (Md.) Sewerage Commission, Jan. 1, to become associated with a contracting firm. Mr. Toner has been with the Sewerage Commission for the past five years and has had charge of the Fallsway tunnel work.

Mr. Isadore Behrman, Jun. Am. Soc. C. E., Assistant Engineer, City Engineer's Department, Baltimore, Md., has been promoted to be Assistant Engineer on the design and construction of the Lake Montebello filtration plant, at a salary of $1800 per annum, succeeding Mr. George F. Wieghardt, resigned, as noted elsewhere.

Mr. J. D. Stack, recently Assistant Superintendent of the Cincinnati, Hamilton & Dayton Ry., at Dayton, Ohio, has been promoted to be Superintendent of the Ohio division of the Baltimore & Ohio Southwestern R.R., at Chillicothe, Ohio, succeeding Mr. E. R. Scoville. Mr. Stack was formerly Division Superintendent of the Oregon-Washington R.R. & Navigation Co.

Mr. C. Terrell Bartlett, Assoc. M. Am. Soc. C. E., of Bartlett & Ranney, Civil and Consulting Engineers, of San Antonio, Tex., has been appointed Consulting Engineer to the County of Bexar, Tex., and will take charge of the construction and reconstruction of all the county bridges which were damaged or destroyed by the recent floods. Mr. Bartlett is to receive a salary of $3600 per annum and is to devote his whole time to the work.

Mr. Thomas P. Stanley, a civil engineer, of Athens, Ga., has been appointed Supervisor of Roads of Georgia. The appointment is made by the State Prison Commission and the duties of the officer are to plan and supervise the labor of convicts on state highways. Mr Stanley is a graduate of the University of Georgia and for 10 years past has had charge of the building of roads in Clarke County, Ga.

Mr. J. F. Deimling, Construction Engineer of the Michigan Central R.R., has been promoted to be Assistant Chief Engineer, succeeding Mr. A. L. Sarvey, assigned to other duties. Mr. Deimling's engineering experience began at 19 years of age as a rodman on the Missouri Pacific Ry., in 1886. He continued to serve in the engineering departments of various Central Western railways, and in 1906 he became Chief Engineer of the Pere Marquette R.R., at Grand Rapids, Mich. He was appointed Engineer of Construction of the Michigan Central R.R., in October, 1912.

Mr. F. T. Beckett, recently Resident Engineer of the El Paso & Southwestern R.R. System at Tucumcari, N. M., has been appointed Engineer of Maintenance-of-way of the Chicago, Rock Island & Pacific Ry., at El Reno, Okla. Mr. Beckett was born at Frankfort, Kan., in 1870, and was educated at Valparaiso, Ind. His first engineering experience was as rodman and chainman with the Atchison, Topeka & Santa Fé Ry., in 1897. Later he was Assistant Engineer of the Chicago, Burlington & Quincy R.R., and of the Atchison, Topeka & Santa Fé Ry. Since March, 1908, he has been Resident Engineer of the El Paso & Southwestern System.

Mr. L. C. Gilman, Assistant to the President of the Great Northern Ry., Seattle, Wash., has been elected President of the Oregon Trunk Ry., the Pacific & Eastern Ry., the United Rys. and other so called Hill lines in Oregon, with headquarters at Portland, Ore., succeeding Mr. Joseph H. Young, resigned to accept service with an Eastern railway, as noted elsewhere. Mr. Gilman, who is the seventh man to hold this office in as many years, is a lawyer, and was formerly Assistant to Mr. James J. Hill, at St. Paul, Minn. He is succeeded at Seattle by Judge Frederick V. Brown, formerly of Minneapolis, Minn., and now General Attorney for the Great Northern Ry., at Seattle.

Messrs. John Price Jackson, F. Am. Inst. E. E., Dean of the School of Engineering at Pennsylvania State College; Samuel A. Taylor, M. Am. Soc. C. E., Consulting Civil and Mining Engineer, Pittsburgh, Penn.; George S. Webster, M. Am. Soc. C. E., Chief Engineer of the Bureau of Surveys, of Philadelphia, Penn.; F. Herbert Snow, M. Am. Soc. C. E., Chief Engineer of the Pennsylvania State Department of Health, and J. Murray Africa, M. Am. Soc. C. E., Consulting Engineer, Huntingdon, Penn., have been appointed by Governor Tener, of Pennsylvania, a State Commission, which is to draft a code to govern the employment of engineers and qualifications of engineers in that state.

Mr. J. C. Stuart, Vice-President of the Erie R.R., will resign Jan. 1, to become Assistant to the President. The Erie R.R. has abolished the office of Vice-President in charge of operation and has reorganized the operating department into three grand divisions, each in charge of a General Manager. Mr. Henry O. Dunkle, General Manager of the lines West of Buffalo, becomes General Manager of the Chicago Terminal division at Chicago, Ill.; Mr. Robert S. Parsons, Assistant General Manager at New York City, becomes General Manager of the Ohio division, at Cleveland, Ohio, and Mr. Albert J. Stone, General Manager of the Eastern lines, becomes General Manager of the Erie division at New York City. The Ohio division will extend from Chicago to Salamanca, N. Y., and the Erie division from Salamanca to New York City. The General Manager of the Erie division will be ranking General Manager and will have charge of all through traffic.

Mr. Joseph H. Young, recently President of the Oregon Trunk Ry., the Pacific & Eastern Ry., the United Rys. and other of the so called Hill lines in Oregon, of Portland, Ore., has resigned to become the head of the New England Navigation Co., the Eastern Steamship Corporation and other steamship lines of the New York, New Haven & Hartford R.R. Mr. Young was born in Salt Lake City, Utah, in 1864. His railway experience began at the age of 18 years as an office boy and storehouseman with the Utah Central Ry. Later he was employed in the passenger departments of the Union Pacific Ry., the Chicago & Northwestern Ry., and other Western lines. He was promoted in the operating departments to be Division Superintendent of the Union Pacific Ry., General Superintendent of the Colorado & Southern Ry., the St. Louis & San Francisco R.R. and the Southern Pacific Ry. In May, 1910, he was elected President of the Alaska Steamship Co., the Northwestern Steamship Co., and Vice-President of the Copper River & Northwestern Ry.; he resigned these offices 2½ years later to become the head of the Hill lines in Oregon

Mr. J. R. Kenly, for the past seven years Vice-President of the Atlantic Coast Line R.R., has been elected President to succeed the late T. M. Emerson, whose death was noted in our obituary columns of Dec. 4. Mr. Kenly was born in 1847 at Baltimore, Md., and has been in railway work continuously for 45 years. He was a son of Gen. John R. Kenly and a nephew of William L. Kenly, once Chief Engineer of the Baltimore Water Department. His election to the presidency of the Atlantic Coast Line adds another name to the list of great railway executives who have risen through the engineering departments, for Mr. Kenly began his railway career as Resident Engineer on the construction of the Pittsburgh & Connellsville R.R. in 1868. Later he was Resident Engineer on the construction of the Union R.R. tunnel in Baltimore, Md., and for 10 years was Engineer, Roadmaster and Superintendent of that railway at Baltimore. In 1882 he was appointed Superintendent of the Richmond & Petersburg R.R. in Virginia, and two years later was promoted to be Superintendent of Transportation of the Atlantic Coast Line R.R., which had absorbed the Richmond & Petersburg. He was promoted to be Assistant General Manager in 1889, General Manager in 1891, and Fourth Vice-President in 1902. From 1905 to date he has been Third Vice-President.

Mr. John Howe Peyton, M. Am. Soc. C. E., Assistant to the President and Chief Engineer of the Louisville & Nashville R.R., Louisville, Ky., has been elected President of the Nashville, Chattanooga & St. Louis Ry., succeeding the late John W. Thomas, Jr., whose death is noted in our obituary columns of this issue. Mr. Peyton was born in Howard County, Mo., Mar. 17, 1864. He was educated at Roanoke College, West Virginia, and started engineering work in 1881 as a rodman on the Richmond & Louisville R.R. For eight years he served in various subordinate engineering positions from rodman to Resident Engineer on various Southern railways. In 1889 he was appointed Assistant to the Chief Engineer of the Charleston, Clendennin & Sutton R.R., at Charleston, W. Va. For six years following 1892 he was engaged in private practice and in general contracting. During the Spanish-American War he served in the United States Army. In 1899 and 1900 he was sent to the Philippine Islands as a member of the Commission of the American (Episcopal) Church. Mr. Peyton returned to railway engineering in 1900 as Resident Engineer of the Chesapeake & Ohio Ry. The next year he was made Chief Engineer of the Great Eastern R.R. In 1902 he joined the engineering staff of the Louisville & Nashville R.R. as Locating Engineer, but left the following year to become Construction Engineer of the Atlanta, Knoxville & Northern Ry. Mr. Peyton returned to the Louisville & Nashville R.R. in 1904 as Locating Engineer, where he remained until 1909, when he was appointed Consulting Engineer of the North Coast R.R., in the Northwest. In 1910 he was appointed Assistant to the President of the Louisville & Nashville R.R., and in 1912 his authority was extended to include the engineering department as Chief Engineer.

Mr. T. Chalkley Hatton, M. Am. Soc. C. E., Consulting Engineer, of Wilmington, Del., has been appointed Chief Engineer of new $13,000,000 sewerage project of Milwaukee, Wis., at a salary of $10,000 per annum for the first two years and $12,000 per annum thereafter. The appointment was made by the new Sewerage Commission, of which Mr. George H. Benzenberg, Past-President, Am. Soc. C. E., is Chairman, as noted in our issue of Oct. 23. A general outline of the organization of this commission was published in our issue of Oct. 16, p. 780. The work of the commission will be the reconstruction of many miles of sewers and the construction of sewage-disposal works. It is expected the work will extend over a period of 10 years and cost approximately $13,000,000, of which $100,000 will be raised this year by a tax levy and $500,000 by direct taxation next year. Mr. Hatton is reported to have been chosen after a careful investigation of the work of several men of national reputation who were considered for the position. Mr. Hatton served as Chief Engineer of the Street and Sewer Department of Wilmington, Del., from 1889 to 1900, and during that period designed and constructed a complete sanitary and storm-sewerage system and a disposal plant, costing in all $1,700,000. Since then he has planned and supervised the construction of sewers in Newport News, Va., Pensacola, Fla., Charleston, W. Va., Berwick, York, Mount Carmel, Coatesville and other places in Pennsylvania, Newark, Del., Hyattsville and Ridgely, Md., Oxford, N. C., and several other places. He has recently completed plans for the revision of the sewerage system of Lock Haven, Penn. As a consulting engineer he has advised the city of Atlantic City, N. J., upon the disposal of its sewage. Four years ago he spent some time in Europe studying sewage-disposal and water-purification systems. Mr Hatton has been engaged in municipal engineering work continuously since 1883, and since 1898 has been in private practice.

OBITUARY

William Willauer, an old-time bridge and road contractor of Pottstown, Penn., died Dec. 17, at the age of 73 years.

Andrew D. Harris, founder of the Ontario Sewer Pipe Co., Toronto, Ont., died in London, England, Dec. 13. He was 54 years old.

Moses Fitzgerald, a civil engineer employed by the Gillespie Bros., Contractors, New York City, died at his home in Paterson, N. J., Dec. 15, aged 41 years.

Victor Spanberg, for many years a member of the engineering staff of the New York Central & Hudson River R.R., died Dec. 16, at his home in Tarrytown, N. Y.

John Hyde, a contracting engineer of Pittsburgh, Penn., died, Dec. 18, at his home in Knoxville, a suburb of Pittsburgh. Mr. Hyde formerly lived in Trenton, N. J., where he was Engineer of Construction for the Trenton Street Railway Co.

Frederick Potter Thorp, M. Am. Soc. M. E., Consulting Engineer, New York City, died in St. Lukes Hospital in that city, Dec. 21, from peritonitis. Mr. Thorp was the New York representative of the Power & Mining Machinery Co., and was formerly connected with Westinghouse, Church, Kerr & Co. He was born at Wyandotte, Mich., in 1868. He is survived by a widow and a 14-year old son.

John W. Thomas, Jr., President of the Nashville, Chattanooga & St. Louis Ry., died at his home in Nashville, Tenn., Dec. 17, from pleuro-pneumonia. He was born at Murfreesboro, Tenn., in 1856. He was educated at Vanderbilt College and began railway work at 22 years of age as an engineman on the Nashville, Chattanooga & St. Louis Ry. He was promoted through various positions in the train service to be Secretary to the President and General Manager in 1886. In 1889 he was made Assistant General Manager and Purchasing Agent. Mr. Thomas was promoted to be General Manager in 1899 and in 1906 was elected President.

Robert Gilmour Leckie, M. Am. Inst. M. E., a charter member of the Canadian Mining Institute and one of the pioneer mining engineers of Canada, died at Sudbury, Ont., Nov. 5, in the 81st year of his age. He was born in Scotland in 1833 and educated at the Glasgow High School and the Glasgow Technical College. He went to Montreal, Que., at the age of 23 years, and for a time was employed in the shipbuilding industry. He afterward he became interested in mining and for a time was associated with early copper-mining projects at Orford, Que. About 1880 he became Managing Director of extensive coal-mine properties in Nova Scotia. In 1890 he engaged in iron mining as General Manager of the Londonderry Iron Co. For several years he was Examining Engineer for Robt. M. Thompson, Consulting Engineer, New York City, and in this capacity reported on mines in New Caledonia, Norway, Sweden and Australia, he was also Consulting Engineer at Sudbury for many years for the Canadian Copper Co.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 29-31. Seventh annual convention at Chicago, Ill. Secy., I. W. Dickerson, Urbana, Ill.

AMERICAN ASSOCIATION FOR ADVANCEMENT OF SCIENCE.
Dec. 29-Jan. 3. Sixty-fifth annual meeting, at Atlanta, Ga. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS.
Jan. 5-7. Fifth annual convention at Washington, D. C. Secy., T. R. Maul, 409 P. O. Building, Philadelphia, Penn.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 13. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 16. Annual convention in New York. Secy., J. R. Wemlinger, 13 Park Row, New York City.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 20-22. Tenth annual convention at New Orleans, La. Secy., F. J. Angier, Timber Preservation Co., Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 21. Annual meeting in New York. Secy., Chas. W. Hunt, 220 W. 57th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting in New York. Secy., E. A. Scott, 29 W. 39th St., New York City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 27-29. Annual meeting in Montreal, Que. Secy., Prof. C. H. McLeod, 176 Mansfield St., Montreal, Que.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Jan. 29-31. Midyear meeting in New York. Secy., H. Donecker, 29 W. 39th St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 4-5. Annual meeting at New York. Secy., Fred E. Irvine, Chicago, Ill.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 12-14. Meeting at Chicago, Ill. Secy., J. P. Beck, 22 W. Adams St., Chicago, Ill.

AMERICAN CONCRETE INSTITUTE.
Feb. 16-20. Annual meeting in Chicago, Ill. Secy., E. E. Krauss, Harrison Building, Philadelphia.

Compressed Air Manufacturers' Association—The annual meeting will be held in New York, on Jan. 29, at 25 Madison Ave. The Secretary is J. J. O'Rorke, 25 Madison Ave., New York City.

Kansas Engineering Society—The annual meeting will be held at Lawrence, Kan., Jan. 20-21. The Secretary is T. J. Strickler, Topeka, Kan.

Indiana Engineering Society—The annual meeting will be held in Indianapolis, Ind., at the Hotel Severin, Jan. 22-24. The annual dinner will take place on Jan. 22. The Secretary is Charles Brossmann, 43 Union Trust Bldg., Indianapolis.

Pacific Northwest Society of Engineers—The annual meeting and year-end dinner of the Society will be held at the Arctic Club, Seattle, Wash., on Jan. 3. The Secretary is Jesse A. Jackson, City Hall, Seattle.

American Society of Mechanical Engineers—On Jan. 9, at 8:15 p.m., at a joint meeting of this Society, the American Institute of Electrical Engineers, and the New York Section of the American Electrochemical Society, the "Power Problem in the Electrolytic Deposition of Metals," will be discussed from the standpoint of the three branches of engineering represented.

American Railway Engineering Association—The nominating committee has announced the following candidates for officers of the Association during the ensuing year: President, W. B. Storey (Vice-President, Atchison, Topeka & Santa Fé Ry. System); Vice-President, A. S. Baldwin (Chief Engineer, Illinois Central R.R.); and Secretary, E. H. Fritch, 962 Monadnock Block, Chicago, Ill.

American Society of Civil Engineers—At the regular meeting on Dec. 17, two papers of unusual interest were presented in brief abstract (see Proc. Am. Soc. C. E., November, 1913, for papers in full).

The first of these papers was a relatively brief one on "The Depreciation of Public Utility Properties as Affecting Their Valuation and Fair Return," by John W. Alvord, of Chicago. The author maintained that if a depreciation fund is actually and properly maintained it should be included in the valuation of the property for rate-making purposes, but if it is diverted from the property or even if it is used as new capital in the property under consideration it is against public interest to include the depreciation fund in the rate-making valuation of the plant. The sinking-fund basis was advocated for computing past depreciation and it was stated that for future depreciation the simpler annual increment method might perhaps be better. Besides written discussions by W. J. Wilgus, Allen Hazen, Leonard Metcalf and others, which were not read and the nature of which was not divulged, there were oral discussions by Alex. C. Humphreys, president of the Stevens Institute of Technology, Fred Lavis and Henry Floy, of New York City, and others. In general, nearly all the oral discussion took issue with Mr. Alvord, Mr. Humphreys with great vigor.

The second paper was on "Storage To Be Provided in Impounding Reservoirs for Municipal Water Supply," by Allen Hazen, New York City. The paper occupies about a hundred pages of the "Proceedings," but its gist was clearly presented by the author in about ten minutes. The paper itself, after presenting many data on stream flow gathered from various sources, submitted "a graphical method of reaching an approximate solution of the problem in probabilities presented by" the many variations in stream flow, which make exact calculations of required storage impossible. The discussion on Mr. Alvord's paper having lasted until 10:10 o'clock no attempt was made to present the large volume of written discussion on Mr. Hazen's paper and only one member discussed it orally. This was Prof. T. U. Taylor, of Austin, Tex., who stated that although he had been a member of the Society for many years that was his first opportunity to attend a meeting and that he had staid in the city a number of days to make use of it. Prof. Taylor called attention to some interesting peculiarities of runoff in the Southwest, which make it impossible to use many of the deductions from the stream-flow observations of the Northeast.